Form No. RZ-NA I-RA/D 140/235 (Version A)
Obsoletes Form I-RA/D 140/235

REZNOR® USED-OIL-FIRED HEATERS AND BOILERS

Installation and Reference Guide

Heater Models

RA 140

RA 235

RAD 140

RAD 235

CSA Certified to Electrical and Fuel Burning requirements only.

P/N 110318 Rev 2

IMPORTANT
Notice to Owner and Installer

To ensure the long term benefits of burning your used oil in a Reznor® Used-Oil-Fired Heater, it is necessary to become familiar with the correct installation and maintenance of your new furnace. Before installing or operating this heater, make sure you have read and understand this manual.

IMPROPER INSTALLATION OR LACK OF MAINTENANCE WILL VOID THE WARRANTY.

The most critical sections of this manual are

- **Correct Draft Over Fire - Page 21**
- **General Maintenance Requirements - Page 24**

Identical to any gas or oil burner, without adequate draft over the fire, the combustion gases cannot escape resulting in an overheated combustion chamber. Even if the burner is installed correctly and adequate draft achieved, a flue passage blockage will affect the draft. Burning used oil is similar to burning wood. A fine gray ash accumulates in the chamber and flue passages. This accumulation of ash will eventually affect the draft. It is important to remove this ash before the draft is affected.

These topics are discussed in detail on the pages listed above. Please familiarize yourself with these sections of your manual. Spending a few minutes to review this material will assure that you receive the return on investment that you expect from your heater.

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Installation

Introduction

Use

This heater is for commercial or industrial use only.

The heater should be installed by an experienced installer thoroughly trained and experienced with the installation of oil-fired appliances. The installer should be familiar with the special precautions necessary in the handling and storage of used automotive oils which may contain small amounts of gasoline.

Codes and Regulations

Installation must comply with:

In the United States

- The Standard for the Installation of Oil Burning Equipment NFPA 31
- The National Electrical Code NFPA 70
- Federal, State, and local municipal codes

In Canada

- CSA Standard B139-M91, Installation Code for Oil Burning Equipment
- CSA Standard C22.1-Canadian Electrical Code, Part 1
- Federal, Provincial, and local municipal codes
- Installation, operating and maintenance permits may be required from regulation authorities covering environmental quality, fuel, fire and electrical safety. Municipal permits may also be required.
- Regulation requires that only used oil generated on the premises of the owner may be burned in this equipment unless written authorization is obtained from the regulatory authority.

Warranty

For Warranty information, refer to the Limited Warranty form in the Owner's Envelope.

WARRANTY IS VOID IF ....

1. Heater is not installed in accordance with these instructions and applicable codes and ordinances.
2. Wiring is not in accordance with diagram furnished with the heater.
3. Heater is operated in presence of chlorinated vapors.
4. Air through the heater is not in accordance with the rating plate.
5. Ducts are attached to RA (fan) model
6. Heater is not maintained in accordance with maintenance requirements. FAILURE TO CLEAN THE COMBUSTION CHAMBER ON A REGULAR BASIS.
7. Other-than-specified fuel is burned.
8. Heater is operated at elevations greater than 3,000 ft (914M) above sea level without factory approved modifications.
9. Fuel input capacity is altered.

Conventions Used in this Manual

Safety Warnings

Hazard Intensity Levels

DANGER: Failure to comply will result in severe personal injury or death, and/or property damage.

WARNING: Failure to comply can result in severe personal injury or death and/or property damage.

CAUTION: Failure to comply could result in minor personal injury and or personal damage.

NOTE: Additional Warnings are also included throughout this manual.

Secondary Heat Source

CAUTION: These heaters are designed to provide economic disposal of used oils. Used oil is an inconsistent fuel and may contain water and/or foreign materials which may cause the unit to shut down. A secondary source of heat should always be provided to the building; do not depend on used oil as your only source of heat. This will prevent building damage should the heater become inoperable during subfreezing weather.

Fuels

WARNING: Approved fuels are No. 2 fuel oil and used automotive transmission fluid and crankcase oils up to 50 weight. Do not attempt to burn any grade of gasoline, paint thinner, or non-approved fluids. Adequate ventilation must be provided in any enclosure where storage tanks, pumps, or accessories are installed.

Hazardous Atmosphere

This heater is not designed for use in hazardous atmospheres containing flammable vapors or combustible dust, or atmospheres containing chlorinated or halogenated hydrocarbons.

Venting

WARNING: Failure to provide proper venting could result in death, serious injury, and/or property damage. Units must be installed with a flue connection, draft regulator and proper vent to the outside of the building. Safe operation of any gravity vented heating equipment requires a properly operating vent system, correct provision for combustion air, and regular maintenance and inspection.

Safety Warnings Continued

Air for Combustion

WARNING: Care should be exercised to ensure that an adequate supply of combustion air is available and free to enter the air openings on all units. Room openings must equal one square inch per each 1,000 BTU heat input.

Non-Compliance

Failure to install or maintain this heater properly will void the warranty.

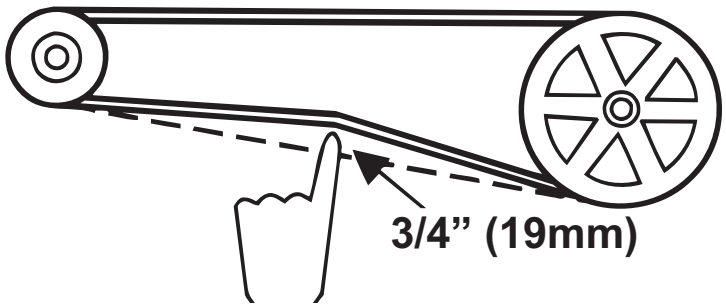
Unpacking and Inspection

Check the heater for any damage that may have occurred in shipment!

If damage is found, file a claim with the transport company. Your unit was inspected and tested at the factory prior to crating and was in perfect condition at that time. Open the boxes and verify receipt of all parts.

To protect the unit during shipping, the blower model (RAD) has special supports that must be removed before installation.

- Blower support legs - Remove the four blower support legs and screws.
- Check Belt Tension - Belt should be able to be depressed 1/2”- 3/4” (13-19mm) - See illustration. If the belt does not have proper tension, adjust by means of the adjusting screw on the motor base. After proper tension is achieved, tighten the lock nut on the adjusting screw.
  Replace the belt guard.



Fan Models (RA) use plastic cable ties to support the fan motors during shipment. Cut and remove prior to installation.

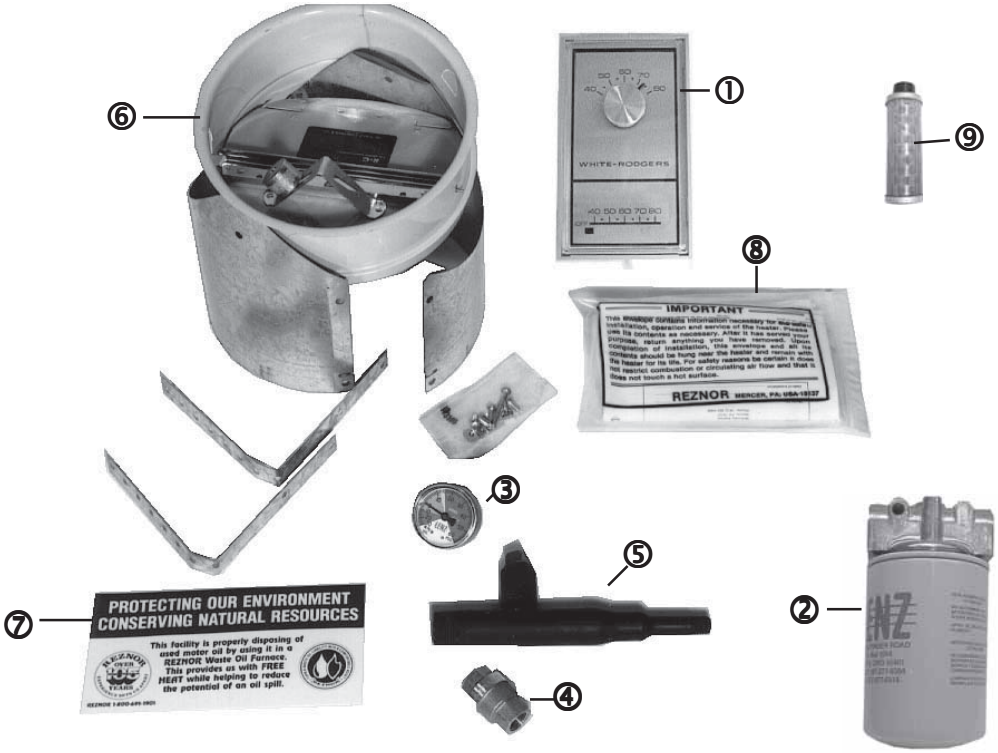
Additional Parts

Shipped with each heater is a remote fuel pump and a carton of parts. The carton contains parts required for installation. Before beginning actual installation, verify that the remote fuel pump and the parts listed below are at the installation site.

Parts Carton

Part No.		Description
207396	①	Thermostat
96388	②	Oil Filter
135986	③	Vacuum Gauge
110320	④	Foot Valve
130952	⑤	Oil Pump Inlet Mar
37866	⑥	Draft Regulator
121030	⑦	Recycling Window Decal
121603	⑧	Warning label (for inlet to fuel storage system/tank)
136864	⑨	Foot Valve Strainer

Pump



Heater Placement

Do not attempt to install this heater until you have read and understand this manual!

Placement is critical to the efficient operation of this heater.

Measure all distances to comply with the specific code requirements and minimum clearances listed below.

Refer to the section on Venting your heater for vent requirements and recommendations.

Locate the heater so that suitable means shall be provided to facilitate regular cleaning and maintenance of the heater (i.e. permanent platform, portable stairs, ladder, etc.).

WARNING: You must comply with all requirements on distance from heater to combustibles.

Minimum Clearances from Combustibles

		Fan Models RA140/235		Blower Models RAD140/235	
		inches	mm	inches	mm
Top		2	51	6	152
Front		48	1219	48	1219
Side (Burner)*	Canada	6	152	6	152
	United States	18	457	18	457
Side (Opposite Burner)*	Canada	6	152	6	152
	United States	18	457	18	457
Rear*		24	610	6	152
Bottom		6	152	6	152
Flue Pipe	Canada	9	229	9	229
	United States	18	457	18	457

*Allow for service access.

In Canada, for additional information on installation clearances, refer to CAN/CSA-B139-M91, “Installation Code for Oil Burning Equipment,” Clause 7.0 - Installation Clearances.

WARNING: Clearances apply to all combustibles. Do not leave paper, rags, or any moveable combustibles near the heater or store gasoline or any other flammable fluid near this appliance.

High Altitude Installation

Standard Model RA/RAD 140 and 235 used-oil-fired heaters are designed for use from sea level up to elevations of 3,000 ft. Without proper modifications severe overheating of the combustion chamber and heat exchanger will occur if installed above 3,000 ft. Also, the onboard air compressor will not deliver the correct amount of atomizing air to the fuel nozzle, resulting in poor combustion. Factory-built high altitude heaters are identified with the suffix "H" (i.e. RA-235-H).

WARNING: Standard model used oil units installed above 3,000 ft (914M) elevation will overheat, damaging the heat exchanger assembly. Use of standard model heater above 5,000 ft (1514M) elevation may result in incomplete combustion and formation of carbon monoxide (CO). Elevations above 3,000 ft (914M) elevation require installation of a heater that is either factory-built or field converted for use at high elevation. Failure to comply can result in severe personal injury or death and/or property damage and will void the warranty.

Check the rating plate for the approved elevations.

Models RA/RAD140

Elevation	Fuel Input		Heat Input		Heat Output	
	GPH	LPH	BTUH	kw	BTUH	kw
0-3,000 ft	1.0	4.5	140,000	41.0	112,000	32.8
>3,000 - 7,000 ft	0.8	3.6	112,000	32.8	89,600	26.1

Models RA/RAD235

Elevation	Fuel Input		Heat Input		Heat Output	
	GPH	LPH	BTUH	kw	BTUH	kw
0-3,000 ft	1.7	7.7	238,000	69.7	190,400	55.8
>3,000 - 7,000 ft	1.45	6.6	203,000	59.4	162,400	47.6
>7,000 ft	1.24	5.6	173,600	50.8	138,880	40.7

If the heater is being installed above 3,000 ft, it must either be factory built (Model 235-H) for that elevation or be changed in the field.

The high altitude conversion affects both the remote pump and the heater. Install the high altitude kit prior to pump and heater installation.

Fuel Tank, Pump, and Supply Lines

General Requirements

Model RA/RAD 140 and RA/RAD 235 heaters are approved to burn used crankcase oil, transmission fluid, and No. 2 fuel oil. Maximum fuel input for a Model 140 is 1.0 GPH (4.5 L/H).Maximum fuel input for a Model 235 is 1.7 GPH (7.7 L/H).

The oil supply tank and fuel lines must be installed in accordance with the National Board of Fire Underwriters requirements and all local ordinances. A UL-listed tank such as Reznor® Model OT-250 or equivalent must be used.

In the U.S., regulations require that storage tanks located inside buildings shall not exceed 275 gallons (1,041 L) individual capacity or 550 gallons (2,082 L) aggregate capacity in one building.

In Canada, regulations require storage tanks located inside buildings shall not exceed 550 gallons (2,082 L) individual capacity or 1,100 gallons (4,164 L) aggregate in one building.

Check with the local Fire Marshall to assure compliance with local ordinances and codes. ***Installation of the tank and supply lines is the responsibility of the installer.***

Fuel Tank

Fuel Tank

CAUTION: It is recommended that used oil be at a temperature of 50°F or higher when it enters the pump. At a temperature below 50°F, oil becomes more viscous and difficult to pump. The heater may fire at a reduced rate and become erratic resulting in nuisance shutdowns.

Install either a UL listed Reznor® Model OT-250 oil supply tank or a field-supplied equivalent indoor storage tank.

- If installing a Model OT-250 tank, follow the installation requirements and instructions on the tank.
- If installing a field-supplied tank, follow the manufacturer's instructions.
- Height from the pump to the bottom of the heater should be no more than 15 ft (4.5M). The used oil supply line should be a maximum of 60 ft (18M) in length.

Although maximum height from the pump to the heater is 15 ft (4.5 M), we recommend that ease of service be considered when determining heater location. A service height of eight feet (2.5 M) is recommended. See the illustrations on pages 12 and 13 for examples of tank and line installation.

WARNINGS: Never pour gasoline or used oil containing gasoline into the supply tank. Adequate ventilation must be provided in any enclosures where storage tanks, pumps, or accessories are installed.

Pump

Remote Fuel Pump

The Model OT-250 tank has a platform designed for attaching the remote fuel pump.

- Attach the fuel pump legs permanently either on the platform, directly to a field-supplied tank, or in a location very near to the oil tank.
- Mount the remote pump assembly in an upright, horizontal position as shown in the illustration.

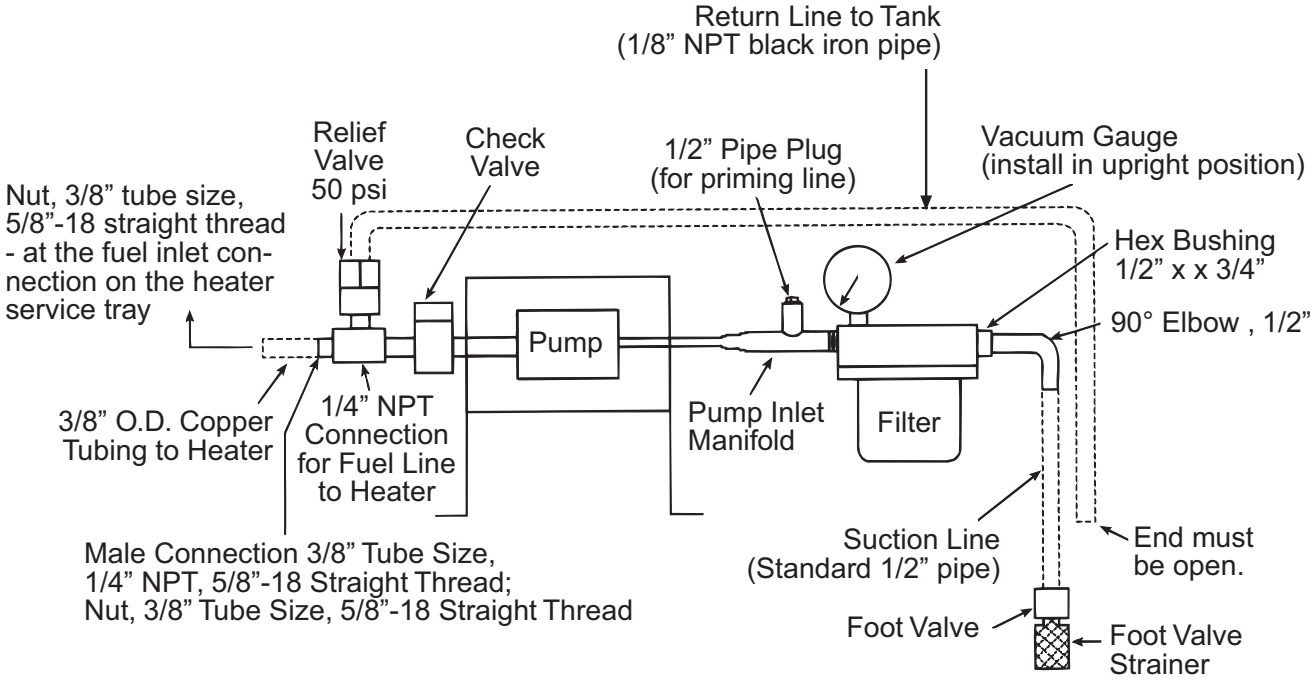
NOTE: Do not mount the pump assembly in a vertical or inverted position.

Supply Lines Installation

CAUTION: Do not use TEFLON® based pipe dope or TEFLON® tape to seal any pipe connections. (TEFLON® is a registered trademark of DuPont Chemical.) Use of TEFLON® based pipe dope or TEFLON® tape will void the pump warranty.

Supply Lines

Read this section carefully before installing any supply lines. Since a suction line leak is nearly impossible to find, take your time to assure all connections are leak-free during installation. **Supply lines and fittings are furnished by the installer.** See the following illustration for minimum fittings required. Length of pipe and tubing depends on the installation.


Return Line to Tank
(1/8" NPT black iron pipe)
Relief Valve 50 psi
Check Valve
1/2" Pipe Plug (for priming line)
Vacuum Gauge (install in upright position)
Nut, 3/8" tube size, 5/8"-18 straight thread - at the fuel inlet connection on the heater service tray
Hex Bushing 1/2" x x 3/4"
90° Elbow , 1/2"
Pump
3/8" O.D. Copper Tubing to Heater
1/4" NPT Connection for Fuel Line to Heater
Pump Inlet Manifold
Filter
Suction Line (Standard 1/2" pipe)
End must be open.
Male Connection 3/8" Tube Size, 1/4" NPT, 5/8"-18 Straight Thread; Nut, 3/8" Tube Size, 5/8"-18 Straight Thread
Foot Valve
Foot Valve Strainer

Suction Line (portion of supply line from foot valve to pump)

Run the suction line, using 1/2" standard black iron pipe, between the inlet side of the filter and the foot valve. (Refer to the illustration.) A fuel line filter with a cleanable strainer, a foot valve, a foot valve strainer, and a vacuum gauge are provided with the heater. To prevent air from entering the line, do not use union connections. Install the suction line components

Supply Lines Installation Continued

Suction Line (cont'd)

as illustrated. With the vacuum gauge mounted on the outlet side of the filter, the gauge will indicate any suction line restriction including a dirty filter. A pump inlet manifold is supplied for direct connection of the filter to the inlet of the pump.

Return Line

The 50 psi relief valve supplied with the pump and a return line of 1/8" NPT black iron pipe must be installed as illustrated.

Discharge Line (portion of supply line from pump to heater)

The discharge line between the valve on the outlet side of the fuel pump and the heater should be 3/8" O.D. copper tubing with a minimum of 1/32" wall thickness with 45° flare fittings. The discharge line must continually rise. A lift height of up to 15 ft (4.5 M) is acceptable with a maximum total length of 60 feet (18 M) of tubing.

Supply Line Connections and Support

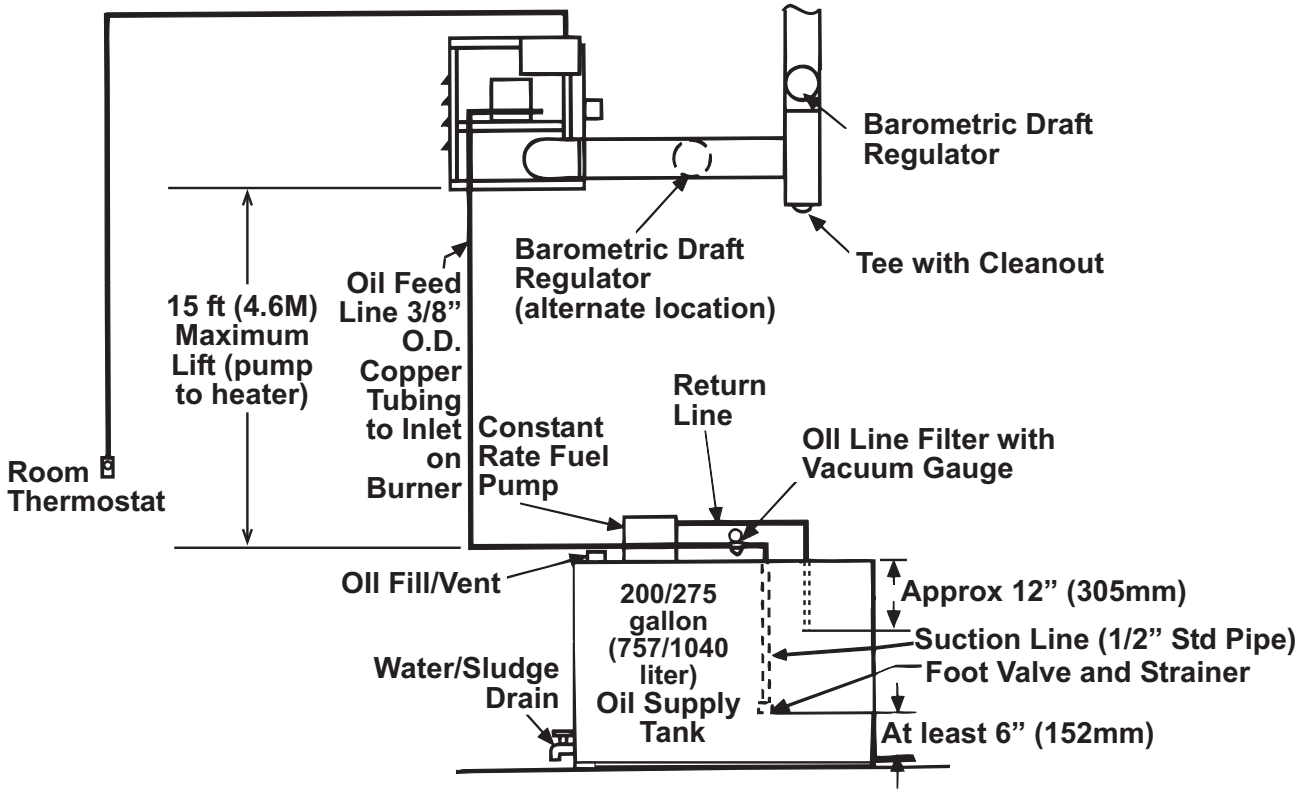
Do not install manual valves in the supply line.

Connect the fuel line to the heater at the connection on the corner of the service tray.

All piping should be protected from possible damage and be rigidly fastened in place in a workmanlike manner. Do not use TEFLON® based pipe dope or TEFLON® tape at the connections in an oil line. Use an oil-resistant pipe dope. Do not use union connections in the suction line (line between the oil supply and the remote pump).

NOTE: *Care must be exercised to ensure airtight connections.*

Typical Installation


Barometric Draft Regulator
Barometric Draft Regulator (alternate location)
Tee with Cleanout
15 ft (4.6M) Maximum Lift (pump to heater)
Oil Feed Line 3/8" O.D. Copper Tubing to Inlet on Burner
Return Line
Constant Rate Fuel Pump
Oil Line Filter with Vacuum Gauge
Room Thermostat
Oil Fill/Vent
200/275 gallon (757/1040 liter) Oil Supply Tank
Approx 12" (305mm)
Suction Line (1/2" Std Pipe)
Foot Valve and Strainer
Water/Sludge Drain
At least 6" (152mm)

Mounting the Heater

General Requirements

Before suspending the unit, check the supporting structure to ensure it has sufficient load-carrying capacity to support the weight of the heater.

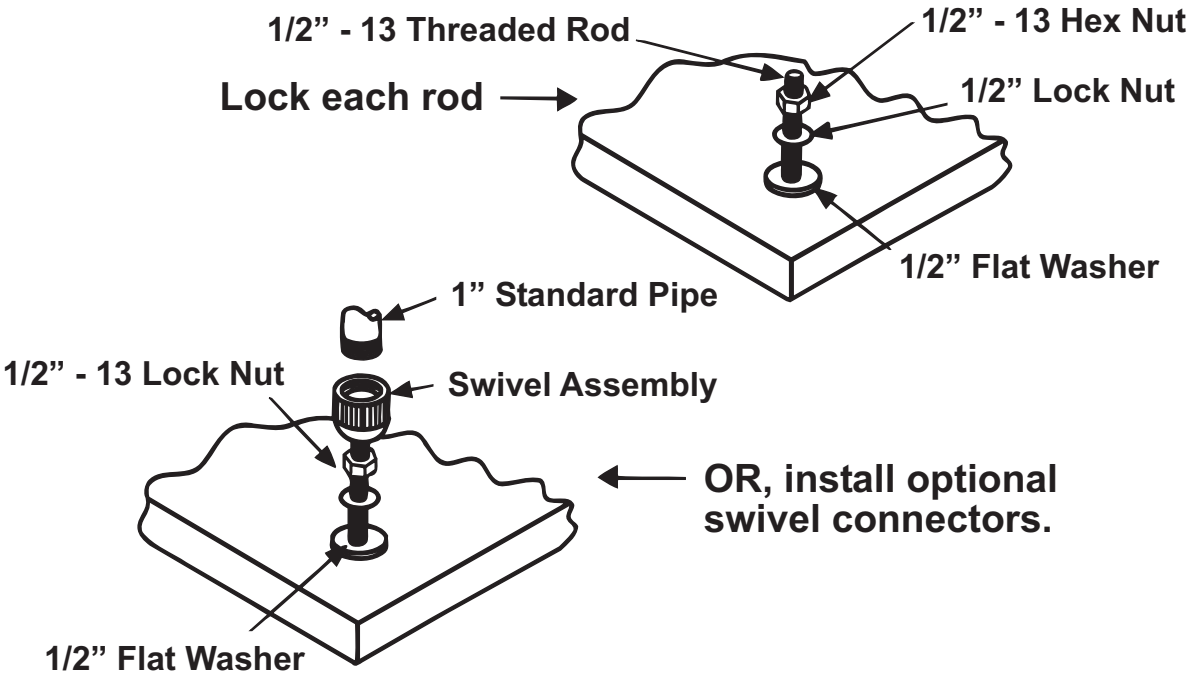
Model	Net Weight	
	lbs	kg
RA140	290	132
RA235	343	156
RAD140	352	160
RAD235	410	186

Suspension

Use four 1/2”-13 diameter threaded rods. Lock each threaded rod using a washer and nut as shown in the illustration below. Or, use optional swivel connections (Option CK10) and field-provided 1” threaded pipe. Lock swivel connections as shown in the illustration. Remove the shipping crate bottom from the unit.

Remove the angle clips and re-insert the screws into the heater cabinet.

WARNING: This heater must be supported level for proper operation. Do not place or add additional weight to the suspended heater.



Venting the Heater

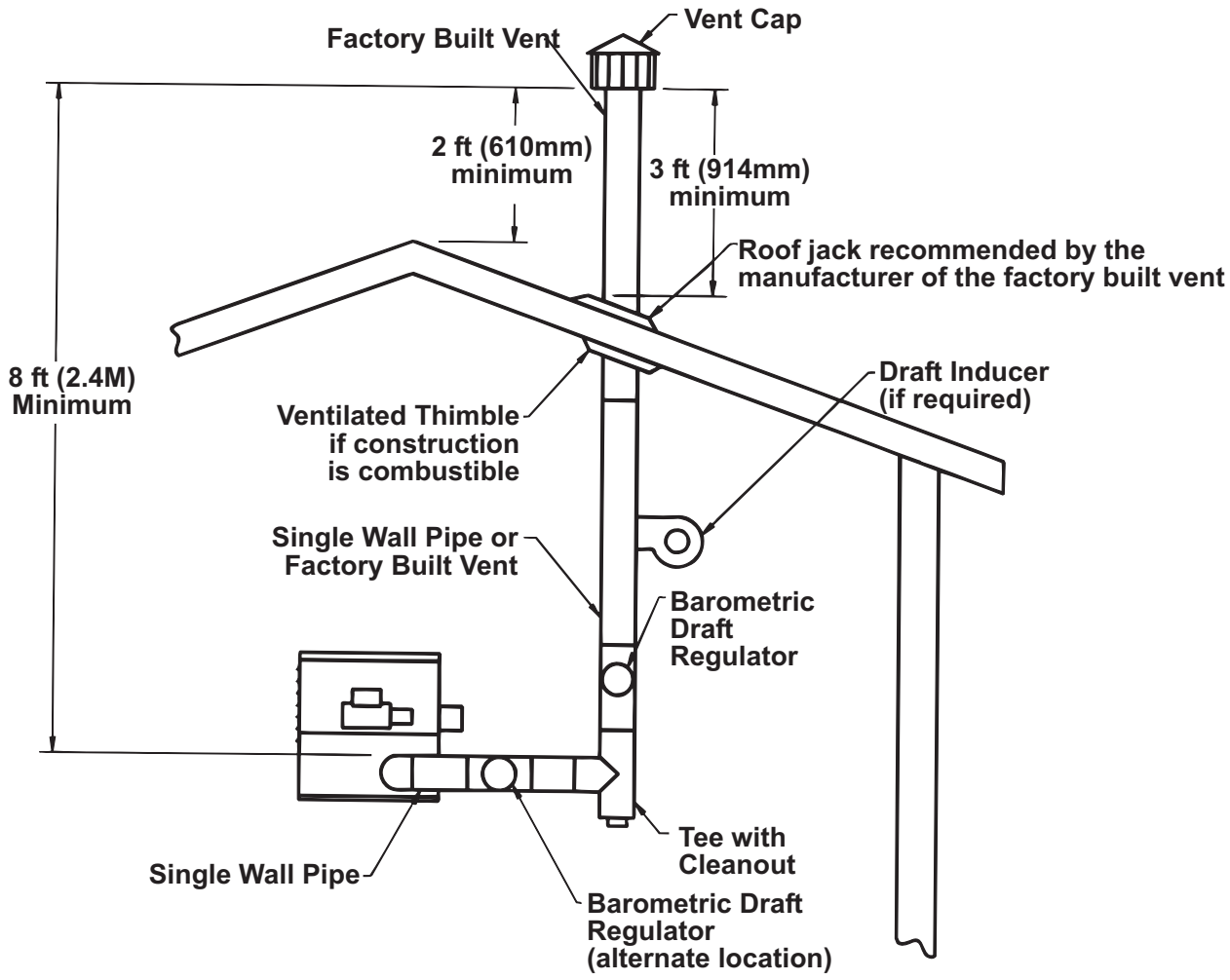
WARNING: Failure to provide proper venting could result in death, serious injury, and/or property damage. Units must be installed with a flue connection and proper vent to the outside of the building. Safe operation of any gravity vented heating equipment requires a properly operating vent system, correct provision for combustion air, and regular maintenance and inspection.

The vent system must comply with all local codes and in the event that local codes do not exist, the vent system must comply with a regional or national code.

Guidelines for the Vent System

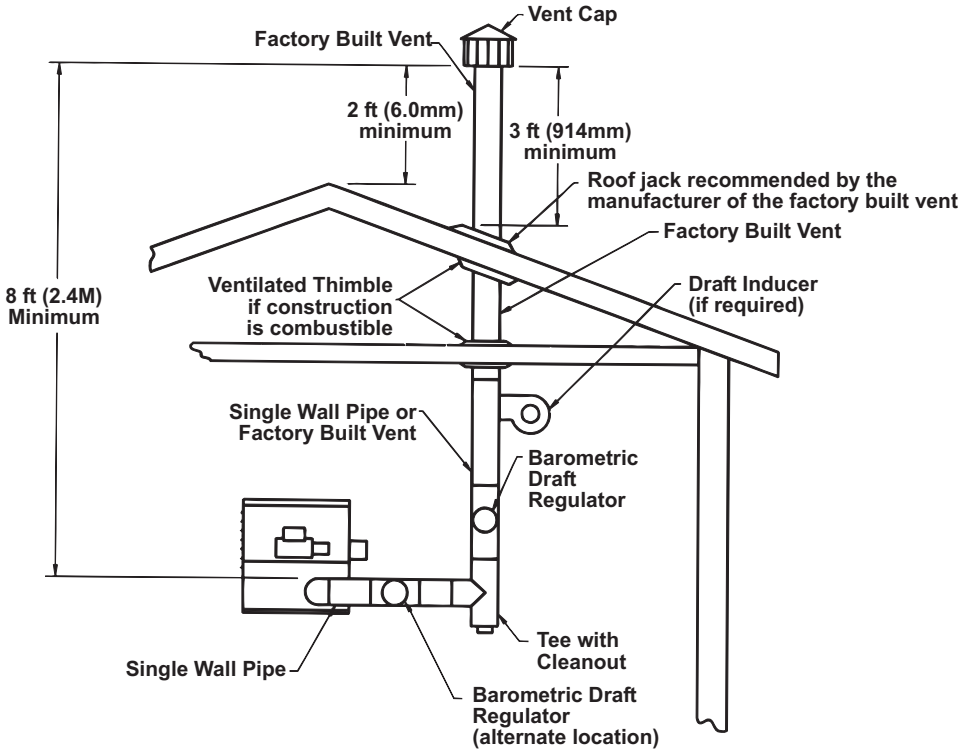
The requirements for the vent system are dependent on (1) the location of the heater within a building and (2) the type of building.

- If the heater and the vent system are within the same heated space, single wall pipe may be used inside the building. The portion of the vent system outside the building must be a factory-built vent that is approved to Standard UL 641. See illustration below.


Factory Built Vent
Vent Cap
2 ft (610mm) minimum
3 ft (914mm) minimum
Roof jack recommended by the manufacturer of the factory built vent
8 ft (2.4M) Minimum
Ventilated Thimble if construction is combustible
Draft Inducer (if required)
Single Wall Pipe or Factory Built Vent
Barometric Draft Regulator
Tee with Cleanout
Single Wall Pipe
Barometric Draft Regulator (alternate location)

- Any portion of the vent system that passes through an unheated space or a concealed area such as an “attic” must be a factory-built vent that is approved to Standard UL 641. See illustration . . . . . .

- The heater may be vented into a masonry chimney that complies with the BOCA National Mechanical Code for low-heat appliances or other building code requirements for low-heat appliances.


Vent Cap
Factory Built Vent
2 ft (6.0mm) minimum
3 ft (914mm) minimum
Roof jack recommended by the manufacturer of the factory built vent
Factory Built Vent
8 ft (2.4M) Minimum
Ventilated Thimble if construction is combustible
Draft Inducer (if required)
Single Wall Pipe or Factory Built Vent
Barometric Draft Regulator
Tee with Cleanout
Single Wall Pipe
Barometric Draft Regulator (alternate location)

Detailed Requirements for the Vent System (*read all before beginning installation*)

- **Pipe/Joints/Clearances:** Single-wall pipe must be a minimum of 24 gauge galvanized steel for 8” or 9” diameter pipe and 22 gauge for 10” or 12” diameter pipe. Each joint must be secured with three screws or rivets. If installing a factory-built vent, follow the manufacturer’s instructions.

  If the vent system passes through a combustible wall, material or roof, for single wall pipe, maintain 18” (457mm) clearance or install a ventilated thimble that is not less than 12” (305mm) larger than the diameter of the vent pipe. If installing factory-built vent, follow the manufacturer’s instructions.

- **Horizontal Length and Slope:** The horizontal portion of the vent must comply with the maximum horizontal length shown in the table below and have not more than two elbows. Horizontal portions must be sloped upward 1/4” for each foot of pipe. If installation conditions require horizontal lengths in excess of those permitted in the table, a draft inducer must be used.

Vent Pipe Diameter	Model Size and Vertical Length	Maximum Length of Horizontal Pipe
8”	**140** with 8 feet (2.4M) or more of vertical pipe	Equal to or less than the vertical height
8”	**235** with 8 feet (2.4M) of vertical pipe	4 feet (1.2M) or less
8”	**235** with 10 feet (3M) of vertical pipe	Equal to or less than the vertical height

- **Vent Size:** The vent system must be at least 8” in diameter.

Detailed Requirements for the Vent System (*read all before beginning installation*) (cont'd)

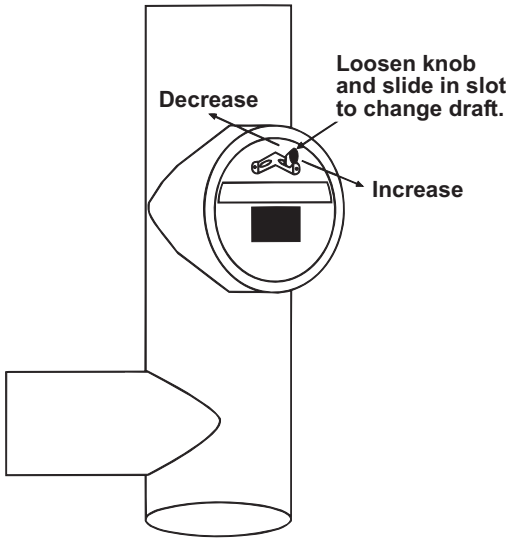
- **Barometric Draft Regulator:** A barometric draft regulator which is the same diameter as the vent pipe ***must*** be used, and it should be located close to the heater. See page 16. **Do not** install a manual damper or any other device that will obstruct the free flow of the flue gases.
- **Support:** The vent system must be adequately supported using non-combustible strapping or supports to carry the weight of the vent and wind load. Do not use the heater to provide support for the vent system.
- **Vertical Vent:** If installing a factory-built vent, follow the manufacturer's instructions.

  If a masonry chimney is used, a thimble that is permanently cemented in place with high temperature cement should be used to permit easy cleaning of the chimney. The end of the vent pipe must not extend past the inside wall of the chimney.
- **Draft Inducer:** If a draft inducer is used, follow the manufacturer's instructions and wire the inducer according to the wiring diagram provided.
- **Terminal End:** The vent must terminate at least 3 ft (914mm) above the highest point of exit and at least 2 ft (610mm) higher than any portion of a building or obstruction within 10 ft (3M) of the chimney. Install a vent cap on the terminal end of the vent. A Reznor (Option CC1) or Type L Breidert Air-x-hauster® vent cap is recommended. A different style of vent cap could cause nuisance problems.

Draft Regulator

A barometric draft regulator is shipped with this heater and MUST be installed in the flue near the heater flue opening.

Refer to the illustrations on pages 14 and 15 for recommended locations. To install, follow the manufacturer's instructions packaged with the draft regulator.



Installing Ducts

Inlet Air Duct

Inlet Air Duct

Canadian installations require field installation of an inlet air duct (return air system) on a Model RAD heater. The blower-equipped heater has an inlet air duct flange. Inlet duct dimensions (inside) should be:

	RAD140	RAD235
Height	32-1/8” (816mm)	32-1/8” (816mm)
Width	21-3/4” (552mm)	31-1/8” (791mm)

Slip the ductwork over the flange and attach using 1/2” long sheet metal screws.

Discharge Duct

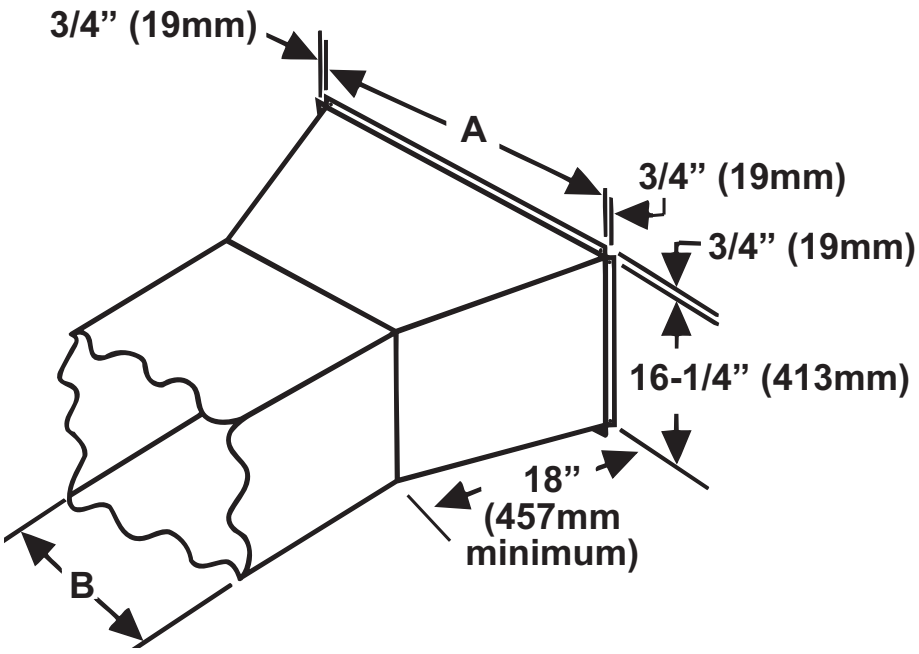
Discharge Duct

Model RAD	140	235
CFM (free air)	2000	3200
Air throw (9 ft suspension)	50 ft 15M	65 ft 20M
CFM .25" ESP	1425	2140

A discharge duct **may be** attached to a Model RAD heater. To connect the duct to the heater,

- Remove the louvers from the furnace.
- Field fabricate a duct transition as illustrated.
- Attach duct transition to the heater using 1/2” long sheet metal screws

IMPORTANT: Never reduce the furnace opening size abruptly. Always use a tapered transition like the one illustrated.



RAD	A	Minimum B
140	30” (762mm)	15” (381mm)
235	40” (1016mm)	20” (508mm)

Heater Power Installation

DANGER: Make sure that the main circuit is OFF before making any wiring connections. All wiring must be done in accordance with appropriate Codes!

Pump Power Installation

Pump Power

To connect the electrical power from the heater to the pump,

- Use a 3 conductor, 14 gauge wire system - two 115 volt conductors and a ground. Use BX if permitted, but make certain to follow local codes for running conduit.
- Refer to the wiring diagram for connecting terminals.

Main Power

To install main power to the system (check the table below and the rating plate on the furnace for current requirements),

- Use #12 gauge stranded copper wire for RA and #8 gauge for RAD to run a dedicated 115 volt, single phase, line from the power source to a junction box mounted on the wall behind the heater or as required by appropriate codes.
- Run the length of appropriate conduit from the heater to the junction box.
- Connect the black wire to the hot lead.
- Connect the white wire to the neutral lead.
- Connect the green wire to the ground lead.
- Install a fused manual reset, line voltage switch (field supplied) in this main line
- Electrical Ratings

Model	Total Current Amperes	Minimum Circuit Ampacity	Maximum Fuse Size (Supply)
RA140	13	16	20
RAD140	24	30	40
RA235	14	18	20
RAD235	24	30	40

Heating Thermostat

A 24-volt thermostat is furnished as standard equipment.

DO NOT attempt to wire relays or other accessories to the thermostat connections as these are not load terminals.

DO NOT install on or suspend the thermostat from the heater

DO NOT install thermostat on a cold outside wall

To install the thermostat,

- Locate the thermostat five feet above the floor on an inside wall, not in the path of warm or cold air currents nor in corners where air may be pocketed
- Remove the thermostat cover
- Make sure the heat anticipator dial is set at 0.2 amps
- Connect the wires through the back of the thermostat to the R & W terminals
- Set the ON/OFF switch on the heater electrical box to the “OFF” position and connect the thermostat wires to the two “T” terminals on the ignition controller.

Heater Start-Up

Burner Start-Up

System Check

Check Test - Prior to Start-Up

You should check your system completely before operating it.

- ☐ Check clearances from combustibles. Be certain that the clearances are in compliance with the appropriate Codes.
- ☐ Check hangers and supports. Be certain that all hangers, supports, and arms are adequately anchored and that all unions or threaded fittings are snug and do not rotate. Heater must be level.
- ☐ Check to make sure all shipping supports have been removed.
- ☐ Check the electrical supply. Be sure that all wire gauges are as recommended and that the supply voltage is as stated on the heater. Determine that fusing or circuit breakers are adequate for the load.
- ☐ Check vents. Be sure that vent pipe and chimney meet the requirements and appropriate codes. A UL or CSA/UL listed draft regulator is required. A Reznor® (Option CC1) or Type L Breidert Air-X-hauster® vent cap is recommended. (Type L Air-X-hauster® is a trademark of The G. C. Breidert Company.)
- ☐ Check the oil supply. Fill the supply tank to at least six inches from the top of the foot valve. **NOTE:** Always screen used oil with a 70-80 mesh strainer when filling the supply tank.
- ☐ Canadian RAD (blower model) installation only -- Be sure an inlet air duct is installed in compliance with Codes.

Priming and Leak Check

For control locations, refer to illustration on page 38

Priming and Checking the System

The oil supply line to the heater must be full of oil and free of air for proper heater operation.

NOTE: Priming the oil line could take up to 30 minutes depending on the length of the line.

Follow the procedure below to fill the oil line.

1. Be sure the oil tank is filled to at least six inches above the top of the foot valve.

Priming and Leak Check Continued

For control locations, refer to illustration on page 38

2. Set manual disconnect switch to the ON position.
3. Fill the suction line (line between the supply tank and the pump) with clean used oil. (Do not use new motor oil.)
4. Locate the rubber tubing connecting the pressure switch in the main control box and the compressor.
   - Disconnect the tubing at the fitting on the compressor. This will prevent oil from flowing to the burner.
5. Remove the cad-cell wire from the F1-F2 terminals of the ignition controller.
   - Either attach a piece of tubing to the bleeder valve on the strainer tee (see page 26) on the burner assembly or place a container underneath to collect oil.
   - Loosen the bleeder valve.
6. Set the thermostat to a temperature above room temperature.

NOTE: On initial start-up it will take approximately ten minutes to heat the oil. Once the oil is warm enough, the green light will come on and the unit will be ready to start. This delay only occurs on initial start-up or when the disconnect switch has been turned off for an extended time.

- After the motor starts, place a jumper across the cad-cell terminals (F1-F2) on the ignition controller.
- Observe the remote fuel pump motor to make certain it is running.
- Open the bleeder valve on the remote pump and wait until a full flow of oil is obtained without any air.

IMPORTANT NOTE: If air bubbles are present and do not stop, there is a suction line leak.

- Check the piping between the tank and the pump and correct the leak.
- Once a full flow of oil is present without any sign of air, close the bleeder valve on the remote pump.
- Observe the bleeder valve at the strainer tee and wait until a full flow of oil is obtained without any air.
- Tighten the bleeder valve on the strainer tee and remove the oil container.

NOTE: DO NOT replace the rubber tubing previously disconnected from the compressor and DO NOT re-connect the cad-cell wires.

7. Allow the system to operate for several minutes.
   - Check the system for leaks at all connections.
   - Observe the return line to the tank - oil should be flowing.
   - Correct all leaks and re-test the system.
8. When the system checks out as having no leaks, turn disconnect OFF, replace the rubber tubing and cad-cell wires removed earlier.
9. Remove the jumper from the F1-F2 terminals of the ignition controller.

You are now ready to start your system.

Heater Start-Up

Start-Up Procedure

After installing and testing your unit, follow the procedure below to start the system.

- Turn on the main electrical supply to the heater.
- Set the manual disconnect switch to the “ON” position.
- Set the thermostat to a temperature above room temperature.

NOTE: When the low oil temperature limit senses the proper oil temperature, the green light on the burner junction box will come on and the heater will fire.

A 10-minute delay may occur before firing depending on the system and the oil temperature. The delay only occurs on initial start-up or after an electrical power interruption.

If the system does not automatically try to re-light, then the controller is in the “lockout” condition and must be reset by depressing the red button on the controller and holding it down for three seconds.

Once the system is purged of all air and oil reaches the nozzle, ignition will occur.

Check-Test

Check Test - After Start-up

Check that there is sufficient draft for proper combustion. A negative draft of .01”-.02” w.c. is required in the combustion chamber over the fire.

NOTE: Draft measurements must be checked anytime there is a change in the air band setting.

Instructions for Measuring Draft Over Fire:

- Remove the metal plug in the observation door.
- Insert draft gauge (such as Dwyer pressure gauge). Measurement must read at least a negative .01” w.c. to negative .02” w.c.
- If measurement is not as required, adjust draft regulator until measurement is within the proper limits (see page 16).
- Replace metal plug in the observation door.

Observation Door - Remove plug; insert draft gauge into port.

NOTE: Heater illustrated does not have a backflow sensor switch. Beginning 1/96, heaters installed in Canada are equipped with a backflow sensor attached to the observation door. Beginning 1/02, all heaters are equipped with a backflow sensor.

Check-Test Continued

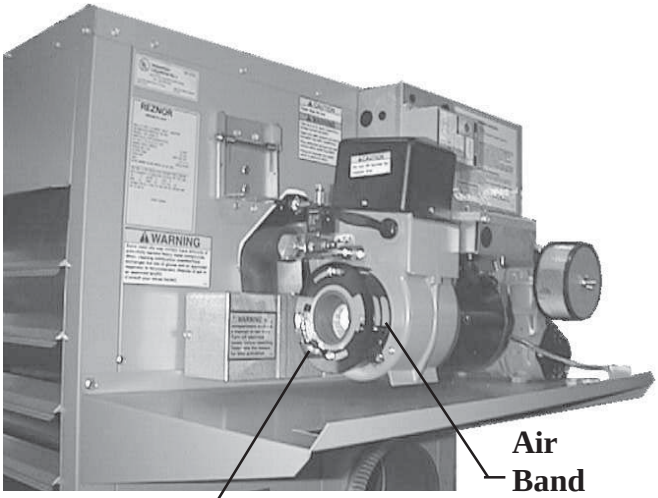
WARNING: If there is insufficient draft, it will create a back pressure resulting in oil fumes in the building and/or pulsating when the burner starts and stops. It may cause excess deposits of soot and overheat the heat exchanger resulting in premature failure of the chamber. THIS TYPE OF FAILURE IS NOT COVERED UNDER THE WARRANTY.

To correct this problem, the height of the chimney may need increased and/or a UL or CSA/ULC listed draft inducer may be installed.

If a draft inducer is used, a draft proving switch must be installed to shut off the fuel supply to the burner in the event of the failure of the draft inducer.

CAUTION: If there is a backdraft or downdraft, do not continue operation of the heater until the situation is corrected. Equipment and/or property damage could result. Back pressure (backdraft or downdraft) may be caused by the chimney being lower than surrounding objects, such as buildings, hills, trees, rooftops, etc. It may be caused by an exhaust fan in the building. The air intake in the room where the heater is installed must be of sufficient size so that there is no change in the draft reading in the flue with the exhaust fan running.

If there is too much draft, it could cause ignition problems, erratic burner, and loss of thermal efficiency. To correct this problem adjust the barometric damper to reduce the draft.



Reference Air Shutter and Air Band Settings

Size	Air Shutter	Air Band	CO_2 Range
140	#1	#1	9.5 - 10.5%
235	#3	#4	10.5 - 11.5%
These are settings **from** which a qualified serviceman/installer **must make adjustments.**			

■ **Combustion air shutter and air band settings.**

Certain installation conditions may necessitate a change in these settings. We recommend that the need for a change be determined by the use of instruments. When obtaining the CO_2 readings, do so with a hot system that has the correct draft settings. With a clean heat exchanger, these settings should result in Bacharach smoke readings not greater than No. 1 and CO_2 reading in the range listed.

IMPORTANT: If it is necessary to change the air band and air shutter settings, the draft measurement must be rechecked.

Check-Test Continued

■ **Check Discharge Air Temperature - Model RAD with discharge ductwork only.**

This heater is designed for a maximum of .25" w.c. static pressure and for discharge air temperature rises from 40° to 50°F.

If the heater has been equipped with a duct, the discharge air temperature should be checked.

- Place a thermometer or a thermocouple in the middle of the outlet or at the end of the discharge duct and measure the discharge air temperature after the heater has operated for at least 20 minutes.

If the temperature rise is not within the specified range, the blower speed will have to be adjusted to achieve the correct temperature rise. If the blower motor maximum amp rating is exceeded, the ductwork must be altered to reduce the static pressure (resistance of the air flow).

Follow these instructions to adjust blower speed.

- Turn off the electrical power.
- Loosen belt tension and remove belt.
- Loosen the set screw on the side of the pulley away from the motor.

To increase blower speed, decreasing outlet temperature

- Turn the adjustable half of the pulley inward.

To decrease blower speed, increasing outlet temperature

- Turn the adjustable half of the pulley outward.

  One turn of the pulley will change the speed 8-10%.
- Tighten the set screw on the flat portion of the pulley shaft.
- Replace the belt and adjust the belt tension.

  Belt tension is adjusted by means of the adjusting screw on the motor base. Adjust until the belt can be depressed 1/2-3/4".
- Tighten the lock nut on the adjusting screw.
- Turn on the electric power.
- Start the heater by turning the thermostat to a setting higher than room temperature.
- Check motor amps with an amp meter. The maximum motor amp rating on the motor nameplate must not be exceeded.

CAUTION: An external duct system static pressure not within the limitation on the heater rating plate and/or improper adjustment of the motor pulley or belt may overload the motor or cause overheating of the heat exchanger.

- While the pump is running, record the vacuum gauge reading and post it on or near the remote pump assembly.

  The maximum allowable vacuum rise is 10" Hg. (Example: With a new oil filter, if the vacuum gauge indicates a suction line vacuum of 3" Hg, the maximum gauge reading is 13" Hg.)
- Display adhesive "Waste Oil Recycling" decal on entry door or window.
- Adhere tank warning label at location visible when filling the tank or at a point where fuel is first introduced to a transfer piping system.
- Return all instruction manuals to the "Owner's Envelope." Follow the instructions on the envelope to keep manuals available for future reference.

Maintenance

General Maintenance Requirements

WARNING: Turn off electric power to the unit before doing any service or maintenance on the heater.

When burning used automotive diesel and truck oils, this heater will require more frequent service than conventional heating equipment. All used oils contain a small amount of ash. This ash is similar in texture to that found in wood burning fireplaces, and varies with the types of oil used. **FAILURE TO REMOVE THIS ASH ON A REGULAR BASIS WILL VOID THE WARRANTY.**

Do not let your oil supply tank run out of fuel. Check the oil level in the supply tank daily to be certain an adequate supply is available. Running out of fuel will require you to re-prime the system.

Maintenance Schedule

The following are starting points for tailoring a maintenance schedule to fit the application. When performing the maintenance procedures listed below, note the hours on the hour meter. After one or two cleanings, the maintenance schedule may be altered based on the hours of operation. However, if there is a major change in the type of used oil being burned, maintenance requirements can be affected. Any time there is a major change in fuel, return to the schedule listed below and note the hour meter readings to retailor the maintenance schedule.

At the end of the heating season or whenever the heater will be shut down for a long period, always turn off the power. Clean the heat exchanger/combustion chamber and the flue pipe. Before restarting, perform all maintenance checks.

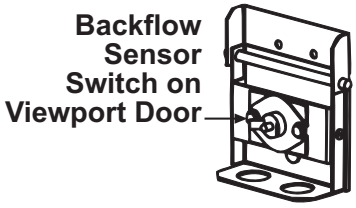
Weekly:

- Check the vacuum gauge on the filter for an indication that the oil line filter needs replaced and/or motor pump screen needs cleaning. The maximum vacuum rise is 10”Hg; the maximum reading is 15”Hg.
- Inspect the combustion chamber and heat exchanger tubes. If cleaning is needed, follow the instructions on page 28.
  Record the hour meter reading for future reference. A Maintenance Record Chart is provided in the Appendix for this record.

WARNING: Wear protective clothing, including gloves and a face mask or respirator. Dispose of ash properly. See the warning statement on cleaning the combustion chamber.

Monthly:

- Drain water from the bottom of the supply tank until a steady stream of oil is obtained.
- Clean the backflow/ash sensor switch. Remove any soot from the sensor. Check the electrical connections.



Every Six months:

- Clean the oil strainer at the burner.
- Clean the foot valve screen.
- Replace the air filter.
- Clean the end cone.
- Replace the oil nozzle.
- Clean the external surfaces of the combustion chamber/heat exchanger.
- Clean the fan or blower.
- Check for oil leaks.
- Check blower belt for tension and wear.
- Inspect the electrodes
- Clean the pre-heater.

NOTE: A maintenance record chart is provided in the Appendix.

Maintenance Procedures

Replace the Supply Line Filter and Clean Internal Pump Screen

Replacing the filter and cleaning the pump screen requires breaking the suction line. The suction line is the portion of the supply line from the tank to the remote pump. If air leaks develop in the suction line, the heater will not operate properly.

Follow all instructions, including "recharging the Suction Line," (page 26) to avoid creating an air leak.

Supply Line Filter with Replacement Canister

Replacing the Supply Line Filter

1. Remove the old filter canister.

- Carefully unscrew and remove the filter canister. Dispose of properly.

2. Replace the filter canister.

- Attach a replacement filter canister, P/N 176535.

Cleaning the Internal Pump Screen

1. Check the Screen

- Disconnect the inlet oil line from the pump.
- Using a flashlight, look into the pump inlet.
  a) If the portion of screen visible at the inlet appears to be clogged, go to Step 2.
  b) If the screen appears unclogged, reconnect the inlet line making sure that the connection is tight. Do not remove the

Cleaning the Pump Cont'd

pump cover. Go to the instructions for "Recharging the Suction Line" (below).

2. Remove and Clean the Screen

- To access the screen, the pump cover must be removed.
- Remove the four bolts that hold the pump cover. (Be careful, pump is full of oil).
- Remove the cover being careful not to lose or damage the gasket.
- Remove the circular screen and clean with a solvent and compressed air.

NOTE: If the screen is damaged during cleaning, replace it with Reznor P/N 123450.

3. Reassemble the pump

- Check the gasket and if a replacement is needed, replace it with Reznor P/N 123451.
- Re-assemble the pump and reconnect the inlet oil line being sure that the connection is tight.

Recharging the Suction Line

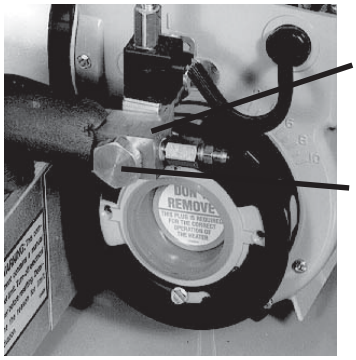
- Remove the fill plug from the inlet manifold and slowly fill the suction line with oil (allow time for air to escape).
- Replace the plug.
- Check vacuum gauge connections and filter housing to be sure that everything is tight. The suction line must be full of oil and all connections tight for the heater to operate properly.

NOTE: Refer to the section, "priming and Leak check" (starting on page 19) for check list and instructions.

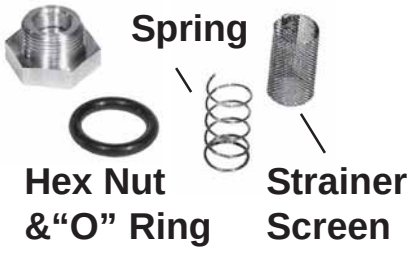
Cleaning the Burner Oil Strainer

Instructions for cleaning the burner oil strainer:

- Identify the strainer tee located in the fuel line just upstream from the burner.



- Remove the hex nut from the end of the strainer tee, being careful not to lose the "O" ring.
- Remove the spring and strainer from the inside of the tee. Clean by washing both the spring and screen with a solvent.



- Reinsert the cleaned screen and spring into the tee. With the "O" ring in place, re-attach the hex nut.

Maintenance Continued

Cleaning Combustion Chamber, Heat Exchanger and Flue Pipe

WARNING: Used oils may contain engine-wear metal compounds and foreign materials. When burned, these compounds are deposited within or exhausted from this heater. Therefore, care should be taken when using, cleaning and maintaining this equipment.

Whenever any cleaning including the flue pipe and exhaust stack is done, proper protective equipment, including gloves and a face mask or respirator, must be worn.

WARNING: Turn off electric power before inspecting or cleaning the unit. Allow unit to cool.

Inspection

To determine need for cleaning, inspect the heat exchanger tubes through the access door on the end of the heater opposite the burner.

- Remove the door panel by lifting upward and outward on the door handle.
- Using a 1/2” wrench, remove the nuts and washers from the inner turning box door.
- Pull the door directly off the studs.
- Shine a flashlight into the heat exchanger.

- **If tubes are 25% blocked, leave covers off and proceed with cleaning.**

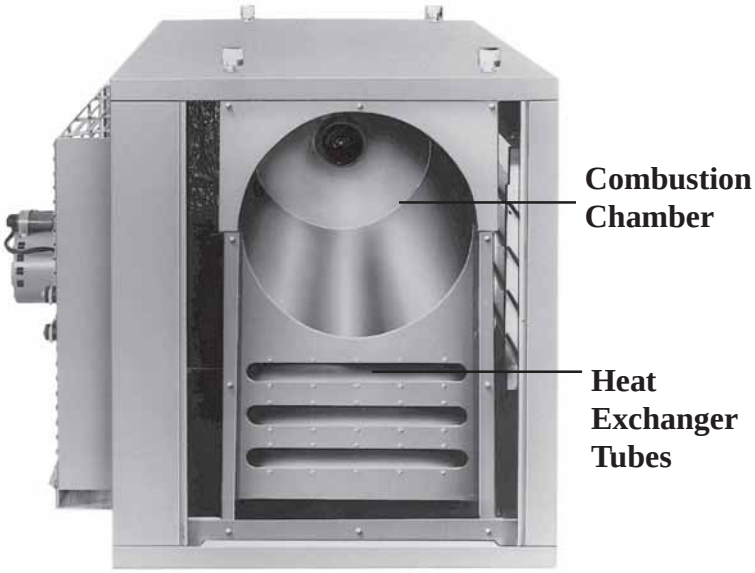
NOTE: You cannot adequately make this determination through the flame observation door. The majority of the settlement of ash accumulates in the heat exchanger tubes.

View with the Outer Access Door Removed

Inspecting and Cleaning the Heat Exchanger/Combustion Chamber (cont'd)

View with Inner Access Door Removed

If tubes are 25% blocked, leave covers off and proceed with cleaning.

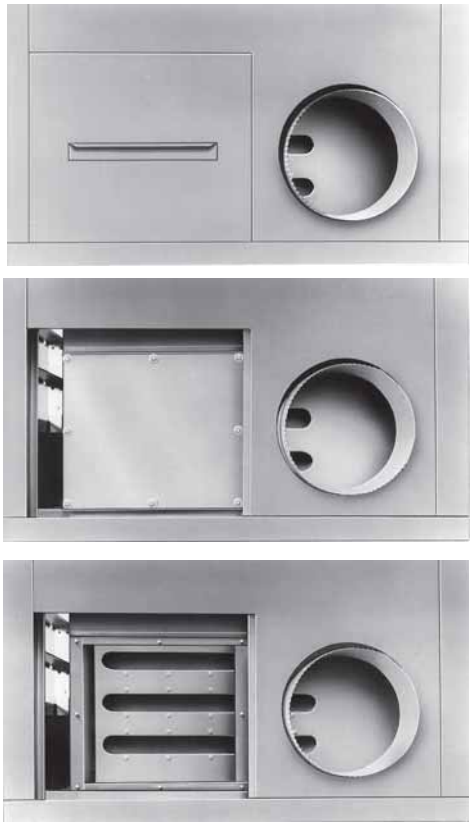


Removing Soot and Ash from the Combustion Chamber, Heat Exchanger, and Flue Pipe

1. On the burner end of the heater, remove the access panel underneath the service tray.
   - Pull the door panel straight out from the heater.
2. Remove the inner access panel (exhaust cover).
   - Using a 1/2" wrench, remove the nuts and washers from the inner exhaust cover.
   - Pull the cover directly off the studs.
3. Clean the combustion chamber (above), heat exchanger, and the flue pipe.
   - Use a stiff brush.
   - Remove ash with a shop vacuum.

WARNING: The ash that is removed from this heater may contain heavy metal compounds that are environmentally undesirable and should be disposed of in a conscientious manner.

5. Check Gaskets
   - Check all access panel gaskets. If replacement gasket(s) are needed, use gaskets identical to the original equipment.
6. Re-assemble



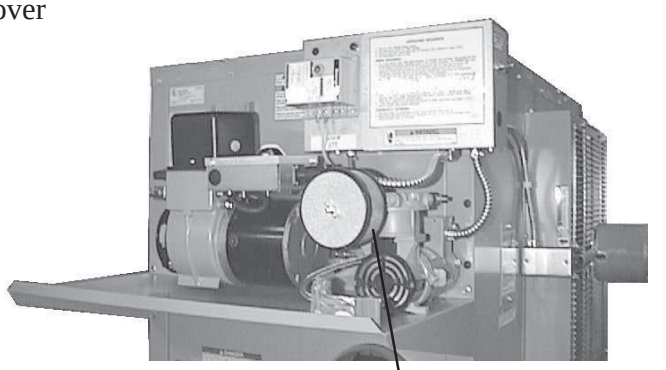
Clean Heat Exchanger Tubes and Flue Pipe

Maintenance Procedures Continued

Replacing the Compressed Air Filter

Locate the compressed air filter.

- Remove the wing nut, the cover plate, and the filter.
- Properly discard the old filter and replace with a new filter (Reznor P/N 107216, Wix Filter No. 43274, or NAPA No. 2374).
- Fasten with cover and wing nut.

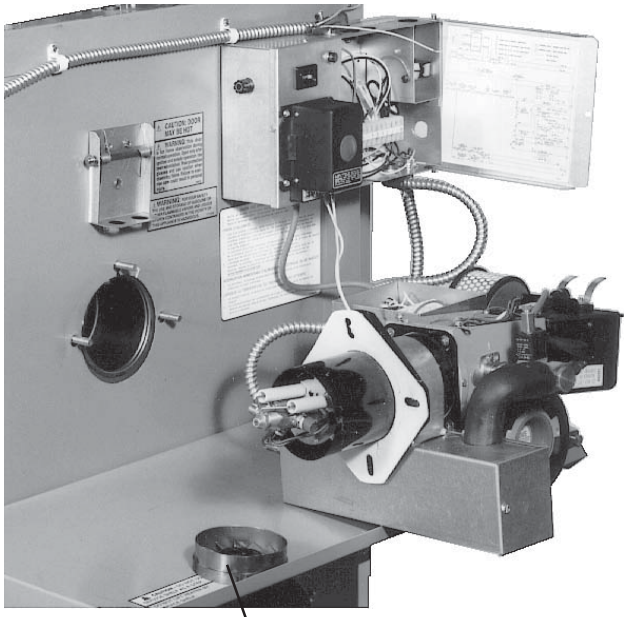


Compressed Air Filter

Removing Burner and Cleaning End Cone, Nozzle, and Electrodes

WARNING: Turn off the electric power before burner is removed for service.

To gain access to the end cone, the burner must be removed.



End Cone Removed

1. To Remove Burner

- Locate the two yellow wires that go from the burner to the ignition controller.
- Disconnect these wires at the terminals on the ignition controller.
- Remove the three nuts and washers that retain the burner to the heater.
- Slide the burner off the bolts and rotate as illustrated.

2. To Remove/Clean the End Cone

- Remove the screws that hold the end cone to the burner tube.
- Remove and clean the end cone using a stiff wire brush.
- Check the end cone for deterioration and replace if deterioration exists.

3. To Remove the Nozzle (requires both a 1” and a 5/8” open-end wrench)

- To prevent the fuel line assembly from twisting, use a 1” open-end wrench to hold the nozzle adapter while removing the nozzle with a 5/8” open-end wrench.

Maintenance Procedures Continued

Removing Burner and Cleaning End Cone, Nozzle and Electrodes Continued

- Clean nozzle by disassembling, washing thoroughly, and blowing dry with compressed air.
- If nozzle face appears worn, replace the oil nozzle with P/N 102997. Annual nozzle replacement is recommended. This nozzle is custom designed. **Do not substitute nozzle.**
- Replace the end cone.

NOTE: Be sure NOT to damage the "O" ring on the nozzle. If the "O" ring appears damaged, replace the nozzle.

4. Inspect the Electrodes

- The electrode porcelain insulators must be free from carbon, oil, dirt, pinhole leaks, cracks, moisture and evidence of over-the-surface arc tracking. Otherwise, short circuiting could cause ignition problems. If any of these conditions exist, replace with new porcelain insulators.
- If a need for service or replacement is determined, see instructions on page 31.

5. Reassemble

- Check the gasket. If in tact, position it over the studs. If damaged, replace with like replacement.
- Line the burner up with the studs and slide the tube into the heater.
- Using the nuts and washers, attach the burner mounting flange.
- Re-connect the yellow wires to the ignition controller.

Removing Fuel Line Assembly to Service Controls and Spark Electrodes (Alternate method for servicing nozzle)

WARNING: Turn off the electric power before removing the fuel line assembly.

NOTE: In order to service the fuel line assembly controls and spark electrodes, it is necessary to remove the fuel line assembly.

Escutcheon Plate

Removing the Fuel Line Assembly

1. Loosen the connection nut one or two turns.

2. Disconnect the fuel connection assembly by loosening the 5/16" inverted flare fitting. Do not change the position of the escutcheon plate.

- Pull the fuel connection assembly clear of the burner housing.

3. Loosen the two transformer hold-down screws.

- Lift the hinged transformer to its open position.

4. There are eight wires in the fuel line assembly wire bundle.

- Mark and disconnect the wires from their terminals in the burner junction box.

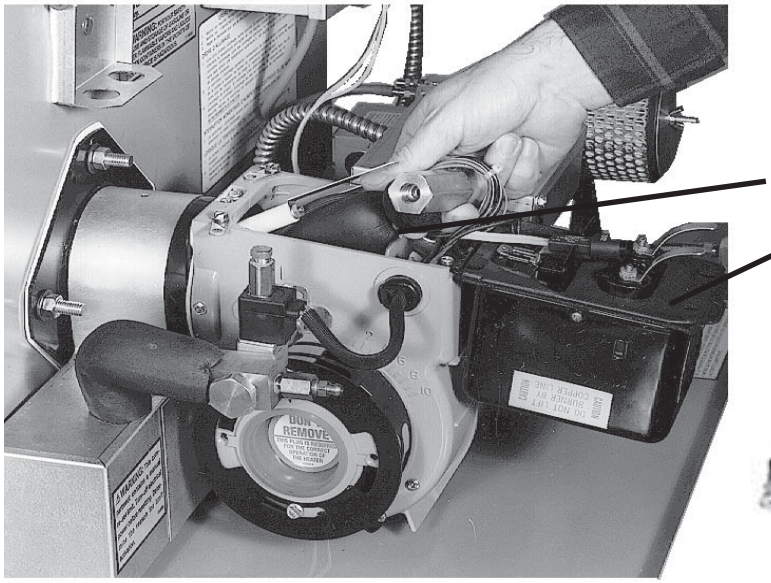
5. Disconnect the nozzle air hose from the fitting at the air compressor.

- Pull the hose through the opening "into" the burner housing.

Maintenance Procedures Continued

6. The fuel line assembly may now be removed by either

- Pulling the assembly up slightly and toward the rear of the burner housing.
- OR removing the burner and end cone and pulling straight out of the blast tube. See pages 29-30 for details.



Servicing/Replacing Spark Electrodes

To service or replace the Spark Electrodes

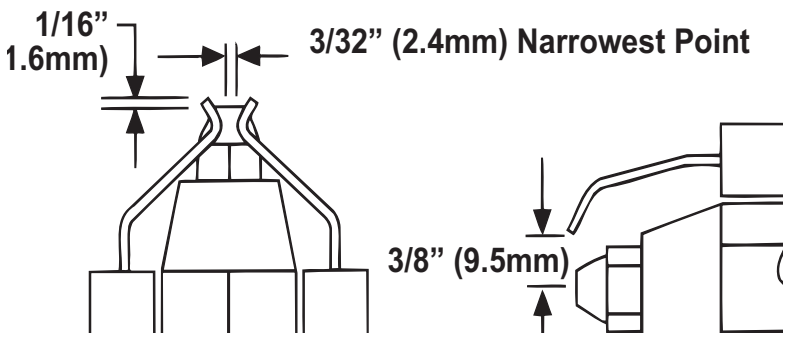
Remove any carbon formation on the spark electrodes.

- Check the electrodes for deterioration and the insulators for cracks or damage.
- Replace the electrode assemblies if any damage or deterioration exists.
- After service or replacement, check the position of the electrodes.
- Adjust the electrode location precisely.

Electrode Adjustment

Check the placement of the electrodes according to the illustration below. If adjustments are required, loosen the 1/4" screw. Make adjustments in the order listed below. Recheck, and if necessary, re-adjust until electrodes are in proper position.

1) From center of nozzle orifice to electrode - **up 3/8" (9.5mm)**
2) Electrode Gap (distance between electrodes - **3/32" (2.4mm)**
3) Relationship of the end of the electrodes to the tip of the nozzle - **1/16" (1.6mm) ahead**
4) Relationship of the tip of the nozzle to the inside radius of the end cone -- **Flush to 1/16" (1.6mm) ahead - NEVER BEHIND**



Maintenance Procedures Continued

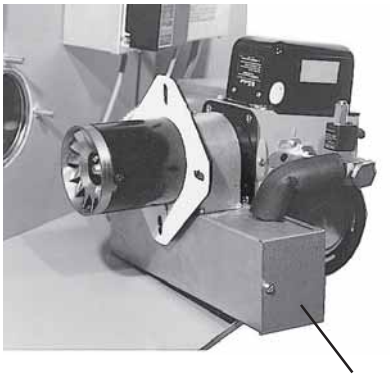
Reassembling the Fuel Line Assembly

1. To reassemble the Fuel Line Assembly
   - Slide the fuel line assembly into the burner housing and the burner tube.
2. Connect the fuel connection assembly to the fuel line assembly.
   - Tighten the 5/16” inverted flare nut firmly. Then tighten the connection nut. Do not move the escutcheon plate.
   - Check the spacing between the oil nozzle and the end cone. Refer to Electrode Adjustment” #4 (page 31).
3. Connect the eight wires in the fuel line assembly wiring bundle. Refer to the wiring diagram in the Appendix of this manual or the wiring diagram on the heater.
4. Push the air line hose out through the burner housing and reconnect it to the air compressor.
5. Close the spark transformer cover and attach with the two screws. Be certain transformer clips make contact with the electrodes.

NOTE: Once assembly is in place, verify that the nozzle, end cone, and electrodes are correctly located.

Cleaning Oil Pre-Heater System (U.S. Patent No. 5,080,579)

WARNING: Turn off the electric power and allow the pre-heater to cool before servicing.



Pre-Heater Box

1. Remove the Burner
- Locate the two yellow wires that go from the burner to the ignition controller. Disconnect these wires at the terminals on the ignition controller.
- Remove the three nuts and washers that retain the burner to the heater. Slide the burner off the bolts and rotate.

Pre-Heater Controls

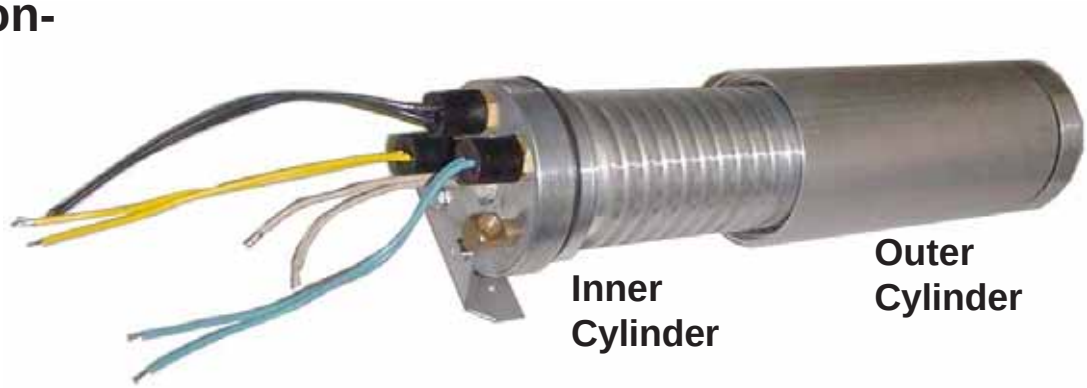
2. Remove the Pre-Heater from the Pre-Heater Box
- Remove the corner panel from the end of the box. The pre-heater controls are visible.
- Disconnect the fuel lines at the inlet and outlet connections. NOTE: There will be oil in the lines.
- Disconnect wires to the temperature controls.
- Disconnect the heating element wires.
- Remove the screw that attaches the pre-heater front support to the bottom of the box.
- Slide the cylindrical aluminium pre-heater out of the box.

Maintenance Procedures Continued

Cleaning Oil Pre-Heater System Continued

3. Clean the Pre-heater

- Place the pre-heater in a vice and carefully remove the outer cylinder and the "O" ring. NOTE: There will be oil in the pre-heater.
- Clean the inner section with a cloth and degreaser such as carburetor cleaner. Be careful not to "clean" the electrical controls. Do not immerse in cleaning fluid.
- Clean the outer portion of the cylinder with degreaser.



4. Reassemble the Pre-Heater and the heater.

- Check the "O" ring. If a new one is required, replace with P/N 132224.
- Reassemble the cylinder pieces with "O" ring in place.
- Slide the pre-heater in the box and attach the front support. Reconnect the wires and the fuel lines and close the corner cover.
- Replace the burner assembly and reconnect the ignition controller.

Cleaning Exterior Surfaces of Combustion Chamber, Heat Exchanger and Air Moving Device

WARNING: Turn off the electric power before cleaning heater.

To gain access to the front side of the combustion chamber/heat exchanger, remove the discharge louvers.

To access the rear side, remove the fan assembly or blower assembly.

To remove the air moving device, disconnect the wiring in the fan/blower junction box and the flexible conduit.

- Use a stiff brush and a shop vacuum to clean the accumulated dust and dirt from the exterior surface of the combustion chamber and the heat exchanger.
- Clean the air moving device (fan or blower). Use a brush and a shop vacuum, being careful not to bend or damage either the fan blade or the blower wheel. Use a shop vacuum to remove accumulated dirt from the motor.
- Replace the air moving device and the discharge louvers.
- Connect the flexible conduit and wiring.

Check operation.

Cleaning ensures maximum efficiency and eliminates the possibility of the heater cycling on the limit switch from lack of air flow.

Service Notes

General Service

Reznor® used-oil-fired heaters have been designed and manufactured to provide years of trouble free operation.

However, as with any type of mechanical equipment, it can malfunction. For your safety, we suggest that if you are unfamiliar with servicing this type of equipment, contact a qualified service person. The material contained in this section is prepared to aid an experienced service person in diagnosing and repairing Reznor Model RA/RAD used oil heaters.

General Operation

How a Reznor® Model RA/RAD Used-Oil-Fired Heater Operates

When service is necessary, it is always helpful to understand the operation of the device being serviced. With this in mind, the following information has been prepared. Because of the many unique features of the heater, we as the designer and manufacturer believe that it will be worth your time to read this information before beginning any service function.

The RA/RAD heaters differ from most residential and commercial oil furnaces and used oil heaters in that the oil pump meters the volume of oil supplied to the burner. A constant volume of oil is delivered by the pump to the burner regardless of the oil viscosity. Oil pressure at the outlet of the pump will vary depending upon oil grade, the length and height of the supply line, and the oil temperature.

If a pressure in excess of 50 psi is experienced at the pump, a relief valve will open and return the oil to the supply tank.

Oil pressure at the atomizing nozzle will vary from .25 psi to 4 psi depending on the type of oil being burned. Nozzle oil pressure is not critical because compressed air is used to atomize the oil.

The solenoid valve located adjacent to the burner housing performs two tasks. The primary task is to prevent oil from flowing into the combustion chamber due to oil expansion in the heater. The second task is to assist in preventing oil from flowing backwards. Both the solenoid valve and the pump motor are turned on and off by the ignition controller. The check valve at the pump prevents backwards flow of oil in both the heater supply line and the suction line to the pump.

To properly atomize the different types of used oil, the oil must be heated. The oil flows through an aluminum heat exchanger (pre-heater) with a 300 watt heating element. This oil heater which is external to the burner preheats the oil to approximately 175°F. A pair of 30 watt heating elements on the fuel line and nozzle assembly within the burner maintain an oil atomizing temperature of 160°F. Temperature sensors prevent burner operation until the proper temperatures are attained. Oil temperature is maintained continuously as long as the electrical power is on to the heater.

Compressed air for atomizing the used oil is supplied by a piston-type compressor mounted on the service tray. Model RA/RAD 140 and 235 heaters require air pressure within a 9 to 12 psi range for proper oil atomization. To

General Operation Continued

assure that the correct atomizing air pressure is available, a pressure switch permits oil flow to the nozzle only when a minimum of 9 psi is sensed.

Combustion air is supplied by a blower contained in the burner housing. An adjustable air shutter and air band located on the outside of the burner housing control the quantity of combustion air. Both are preset at the factory and should be changed only if the CO_2 measurement indicates the need to do so. See Check-Test-Start, for instructions for measuring CO_2.

Ignition of the atomized oil and combustion air mixture is accomplished by a high voltage spark across the two electrodes located near the atomizing nozzle. Ignition of the oil is detected by a cadmium sulfide flame sensor. Light produced by the flame lowers the electrical resistance of the cad cell. This change is sensed by the ignition controller which allows a continued flow of oil and shuts off the spark transformer after a 30-second trial-for-ignition period.

If for some reason, ignition does not occur or the flame goes out during the trial period, the primary control will lockout. To restart, the safety switch must be manually reset by pushing the red reset button on the ignition control. Depress and hold the reset button for three seconds. If the heater does not ignite, contact your service person.

If the instructions in this manual are followed, excessive amounts of unburned oil will not accumulate inside the combustion chamber. If the caution statement about resetting the controller more than one time is not heeded, then unburned oil will accumulate in the combustion chamber. **If unburned oil accumulates, DO NOT** attempt to fire the heater and burn off the oil. Remove the combustion chamber access panels as described in Maintenance Section, “Inspecting and Removing Soot and Ash from the Combustion Chamber/Heat Exchanger”. Wipe out any accumulated oil with cloth rags. Properly dispose of the rags.

CAUTION: Do not reset the primary control more than one time. If the heater does not ignite, contact your service person.

If the flame fails during normal operation, the heater will go into lockout requiring manual reset of the primary controller. Depress and hold the reset button for three seconds. If the heater does not ignite, contact your service person.

If power fails, the heater will shut down and normal trial for ignition will begin on call for heat when the power is restored.

Approximately 1-1/2 to 2 minutes after the thermostat calls for heat and ignition is established, the circulating fans or blowers will come on. The circulating airflow will continue about three minutes after the burner shuts down.

Troubleshooting

Oil Burner Troubleshooting

To diagnose malfunctions properly, the following test equipment is required:

1) An electrical test meter that can measure AC volts, ohms, and amps;
2) A combustion analyzer kit to measure oxygen and/or carbon dioxide, smoke, stack temperature, and draft; and
3) Two pressure gauges with scales of 0-100 PSIG and 0-30 PSIG.

Before test firing any heater, check the combustion chamber for an excessive accumulation of unburned oil and restore to safe condition before firing. (See page 35.)

WARNING: Do not attempt to start the burner when excess oil has accumulated, when the furnace is full of vapor, or when the combustion chamber is very hot.

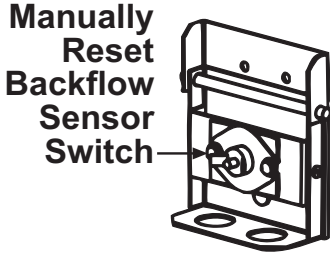
NOTE: Refer to the troubleshooting guide on page 37 to select the appropriate troubleshooting chart.

Check the Indicator Lights

Light	Location (on the Electrical Box)	Function
GREEN	On the side next to disconnect (on/off) switch	Indicates that the main power is on to the heater
GREEN	On the fixed-cover portion above the ignition controller	Indicates that all limits have been satisfied and the unit is ready to operate

Backflow Sensor

Viewport Cover



Backflow Sensor Switch

Description/Application - The backflow sensor is a temperature-sensitive switch that is designed to shutdown the heater when there is a positive pressure in the combustion chamber The heater is designed to operate with an overfire draft of -0.01” to -0.02” w.c. Prolonged operation at a positive pressure (greater than or equal to 0.00” w.c.) can cause overheating and accidental component failure. Undesirable positive furnace pressure can be caused by any one or a combination of the following conditions:

- Totally or partially blocked flue gas venting system
- Improperly designed venting system
- Improper fuel-to-air ratio for combustion
- Excessive ash buildup on interior heat exchanger surfaces
- Blocked heat exchanger passages
- Improper atomization of the fuel
- Plugged or defective fuel nozzle
- Improperly adjusted fuel nozzle assembly
- Burning off-specification fuel
- Changes in outside ambient temperature

Backflow Sensor Switch Continued

Location - The backflow sensor switch is mounted on a bracket on the hinged viewport cover on the control side of the heater. The location is important in the operation of this switch. Except for limited observation, the viewport cover must be kept closed for the sensor (and heater) to operate properly.

Operation - Underneath the sensor bracket, the viewport cover has a 3/8" diameter hole. Under normal negative overfire operating conditions, room air is constantly drawn into that small opening. The temperature-sensitive backflow sensor is "cooled" by the air flow. If for any of the reasons listed, the furnace pressure becomes zero, or slightly positive, the flow of air decreases. If this condition persists (10 minutes maximum) the "uncooled" backflow sensor activates interrupting power to the ignition controller. The green limit status light will go out; the heater will go through the normal post purge and cool down cycle.

After the problem has been determined and corrected, push the manual reset button on the backflow sensor, and follow the instructions to relight the heater. Check for proper operation.

Maintenance - A thin film of soot will form on the face of the backflow sensor. At least once a month and during any routine heater cleaning, open the viewport cover and clean the soot from the sensor. Check the wire connections during scheduled maintenance inspections.

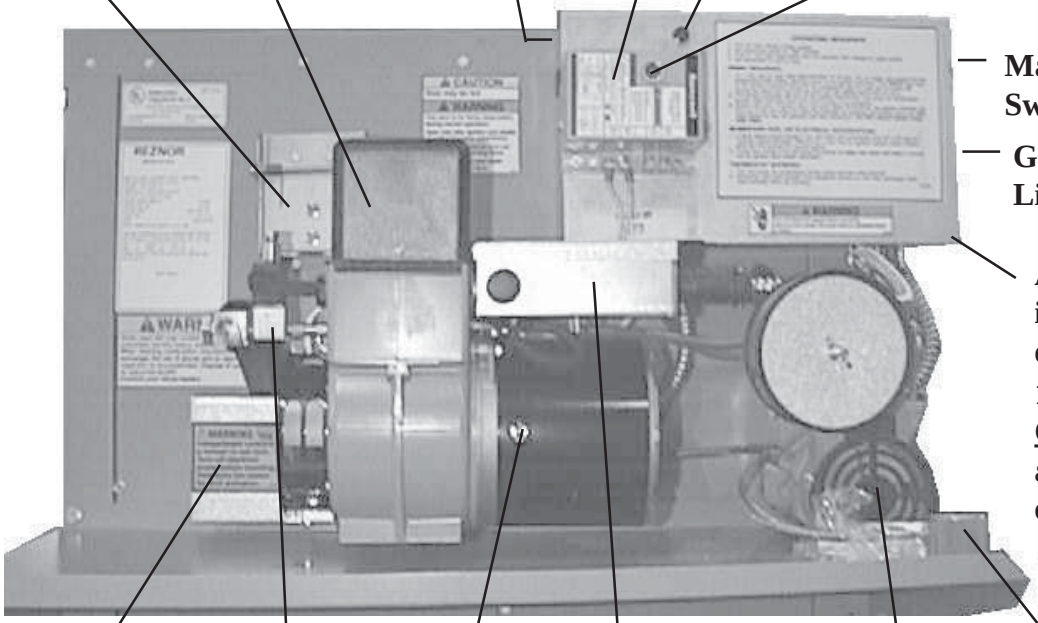
Troubleshooting Chart Guide

Symptoms	Follow Troubleshooting Chart
With thermostat calling for heat, burner motor never attempts to run (Green "power on" light is lit; Green "system ready" light is not lit).	**Chart No. 1, page 39**
Chart 1 check completed, but burner motor never attempts to run. With thermostat calling for heat, burner motor runs momentarily.	**Chart No. 2, page 41**
System does not attempt to ignite.	**Chart No. 3, page 42**
Burner ignites and burns steadily until system goes into lockout.	**Chart No. 4, page 43**
Burner operation erratic/unstable flame pattern.	**Chart No. 5, page 44**
High temperature limit cycles.	**Chart No, 6, page 45**
Oil delivery system troubleshooting.	**Chart No. 7, page 47**

CAUTION: The items on the Troubleshooting Charts that are marked with an asterisk represent events that have occurred due to the improper functioning of the heater. It is necessary to observe the operation of the heater to determine what caused these events to occur.

Troubleshooting Continued

Location of Components Referenced in Troubleshooting Charts



Backflow Sensor Switch on the Viewport Door (not illustrated) - on heaters installed in Canada beginning 1/96; on all units beginning 1/02

10 amp fuse mounted on the end of the electric box. See wiring diagram. NOTE: Fuse is on all units installed in Canada; on U.S. units beginning 1/02.

Ignition Controller

Green Light: Limits are satisfied; heater is ready to operate.

Transformer (NOTE: To access cad cell, open transformer.)

Ignition Controller Reset

Manual Disconnect Switch

Green Indicator Light ("power on")

Air pressure switch is inside the main electrical box.

115V Terminal Connections 1-10 are inside the main electrical box.

Oil Inlet Connection

Box contains oil heat exchanger (pre-heater) with 300 watt heating element and temperature controls. Remove cover to access.

Burner Motor Reset Button

115V Terminal Connections 11-18 are in the burner junction box.

Piston-type Air Compressor

Burner Tee with Strainer

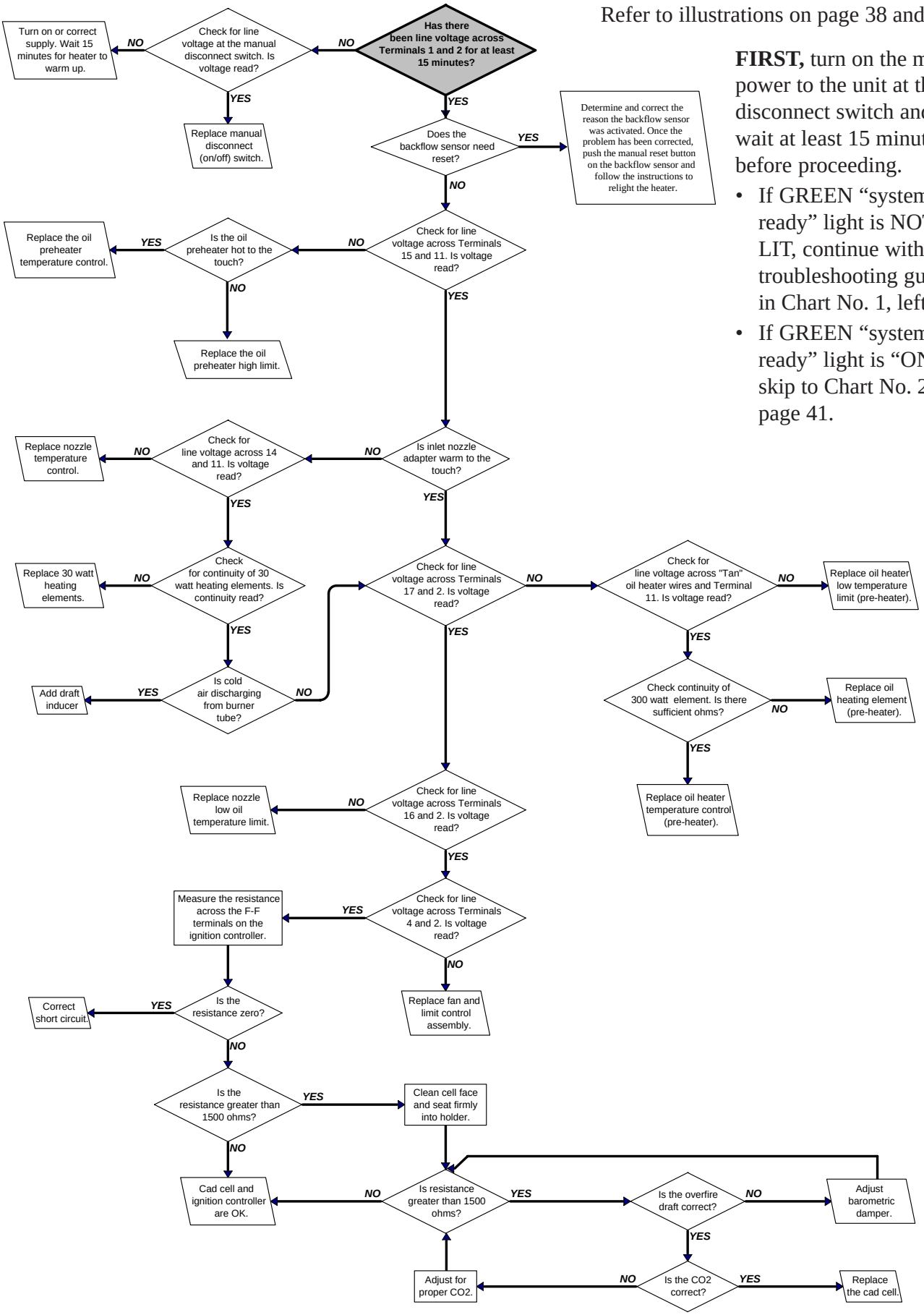
Troubleshooting Continued

Chart No. 1 - Thermostat calling for heat; Burner motor never attempts to run.

Refer to illustrations on page 38 and 40.

FIRST, turn on the main power to the unit at the disconnect switch and wait at least 15 minutes before proceeding.

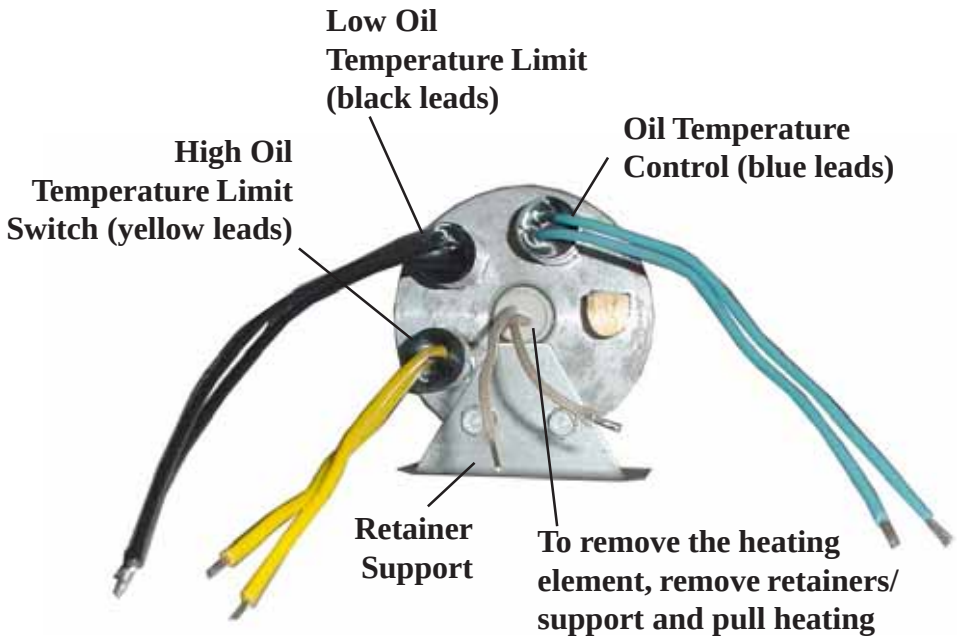
- If GREEN "system ready" light is NOT LIT, continue with the troubleshooting guide in Chart No. 1, left.
- If GREEN "system ready" light is "ON", skip to Chart No. 2, page 41.


Has there been line voltage across Terminals 1 and 2 for at least 15 minutes?
NO
Check for line voltage at the manual disconnect switch. Is voltage read?
NO
Turn on or correct supply. Wait 15 minutes for heater to warm up.
YES
Replace manual disconnect (on/off) switch.
YES
Does the backflow sensor need reset?
YES
Determine and correct the reason the backflow sensor was activated. Once the problem has been corrected, push the manual reset button on the backflow sensor and follow the instructions to relight the heater.
NO
Check for line voltage across Terminals 15 and 11. Is voltage read?
NO
Is the oil preheater hot to the touch?
YES
Replace the oil preheater temperature control.
NO
Replace the oil preheater high limit.
YES
Is inlet nozzle adapter warm to the touch?
NO
Check for line voltage across 14 and 11. Is voltage read?
NO
Replace nozzle temperature control.
YES
Check for continuity of 30 watt heating elements. Is continuity read?
NO
Replace 30 watt heating elements.
YES
Is cold air discharging from burner tube?
NO
Add draft inducer
YES
Check for line voltage across Terminals 17 and 2. Is voltage read?
NO
Check for line voltage across "Tan" oil heater wires and Terminal 11. Is voltage read?
NO
Replace oil heater low temperature limit (pre-heater).
YES
Check continuity of 300 watt element. Is there sufficient ohms?
NO
Replace oil heating element (pre-heater).
YES
Replace oil heater temperature control (pre-heater).
YES
Check for line voltage across Terminals 16 and 2. Is voltage read?
NO
Replace nozzle low oil temperature limit.
YES
Check for line voltage across Terminals 4 and 2. Is voltage read?
YES
Measure the resistance across the F-F terminals on the ignition controller.
NO
Replace fan and limit control assembly.
YES
Is the resistance zero?
YES
Correct short circuit
NO
Is the resistance greater than 1500 ohms?
YES
Clean cell face and seat firmly into holder.
NO
Cad cell and ignition controller are OK.
NO
Is resistance greater than 1500 ohms?
YES
Is the overfire draft correct?
NO
Adjust barometric damper.
YES
Is the CO2 correct?
NO
Adjust for proper CO2.
YES
Replace the cad cell.

Oil Heat Exchanger and Fuel Line Assembly Reference Chart No. 1

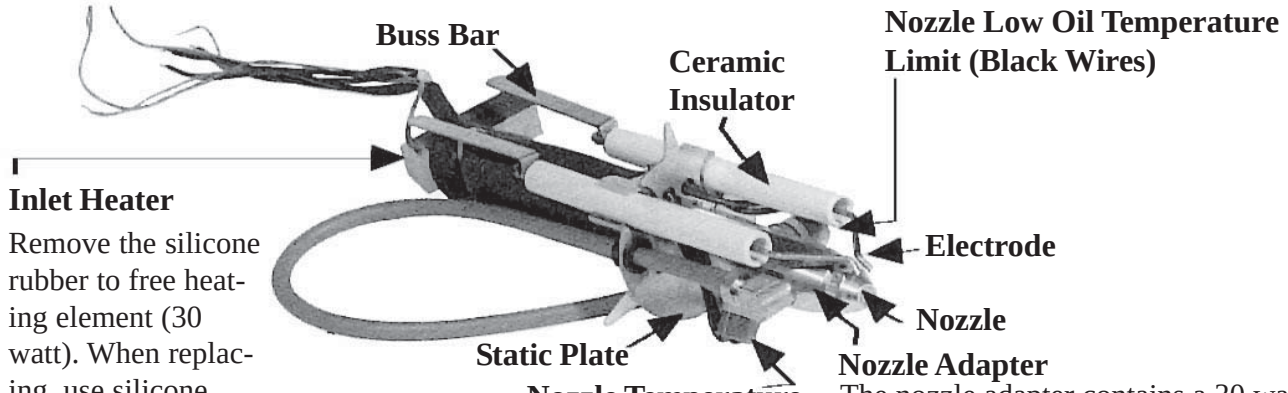
Locations and Replacement Instructions for Heating Element and Temperature Controls on Oil Pre-heat Heat Exchanger

Refer to illustration on page 38.


Low Oil Temperature Limit (black leads)
Oil Temperature Control (blue leads)
High Oil Temperature Limit Switch (yellow leads)
Retainer Support
To remove the heating element, remove retainers/ support and pull heating element forward.

Remove limit switches with open-end wrench. Do not rotate using terminals.

Locations and Replacement Instructions for the Two 30 Watt Heating Elements in the Fuel Line Assembly



Inlet Heater

Remove the silicone rubber to free heating element (30 watt). When replacing, use silicone rubber to retain the new element.

Nozzle Adapter

The nozzle adapter contains a 30 watt heating element. To replace the element:

1) Remove the buss bars.
2) Unscrew the inlet heater and slide the black insulation rearward. Loosen set screw which retains the static plate and slide rearward. This will expose the heating element.

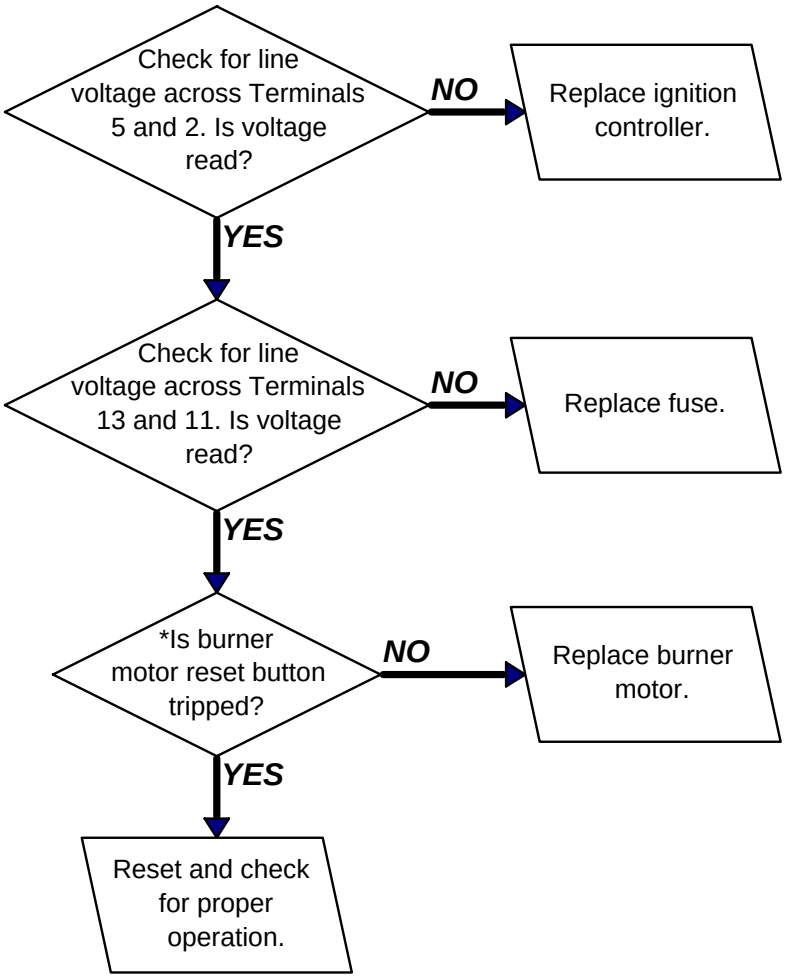
Troubleshooting Continued

Refer to illustration on page 38.

Chart No. 2 - Thermostat calling for heat, burner motor never attempts to run (green light is lit) indicating “System Ready”. Chart No. 1 has been successfully completed.

NOTE: After ignition control is reset, you will have 30 SECONDS to perform the tests shown below before the controller locks out.

Reset ignition control: Press the RED BUTTON, hold for four seconds, and release. DO NOT RESET MORE THAN ONE TIME.



*Reset button on the motor activates when the motor is overheated. Motor amp draw must be less than the full load amps on the motor rating plate. Verify the motor is operating correctly.

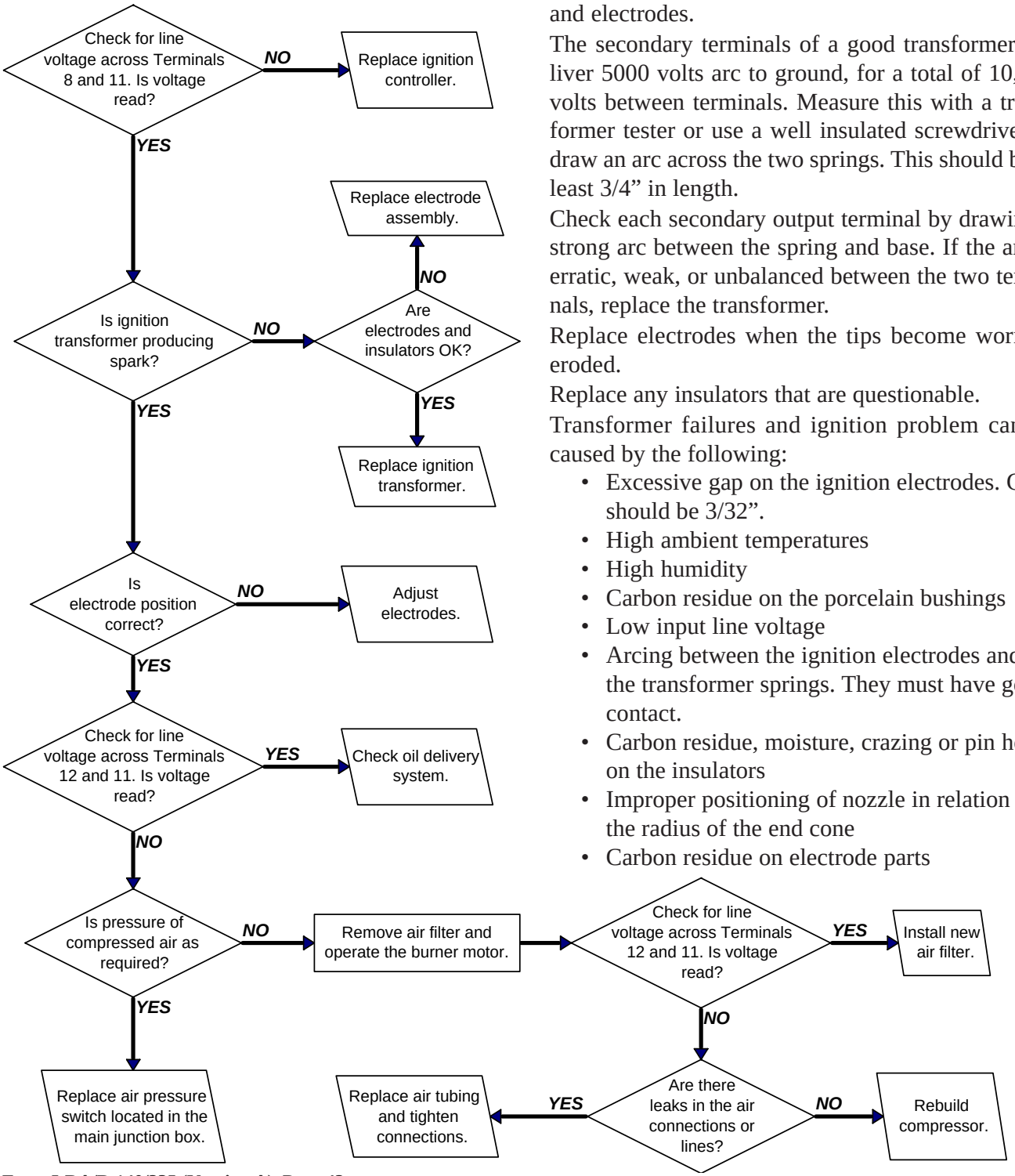
Troubleshooting Continued

Chart No. 3 - Thermostat is calling for heat. Burner motor runs for about 30-45 seconds. System does not attempt to ignite.

First, check combustion chamber for excess oil.

NOTE: After ignition control is reset, you will have 30 SECONDS to perform the tests shown below before the controller locks out.

Reset ignition control: Press the RED BUTTON, hold for three seconds, and release. DO NOT RESET MORE THAN ONE TIME.



Transformer and Electrode Checks:

Measure voltage between transformer/primary lead and neutral connection. Check transformer, insulators, and electrodes.

The secondary terminals of a good transformer deliver 5000 volts arc to ground, for a total of 10,000 volts between terminals. Measure this with a transformer tester or use a well insulated screwdriver to draw an arc across the two springs. This should be at least 3/4" in length.

Check each secondary output terminal by drawing a strong arc between the spring and base. If the arc is erratic, weak, or unbalanced between the two terminals, replace the transformer.

Replace electrodes when the tips become worn or eroded.

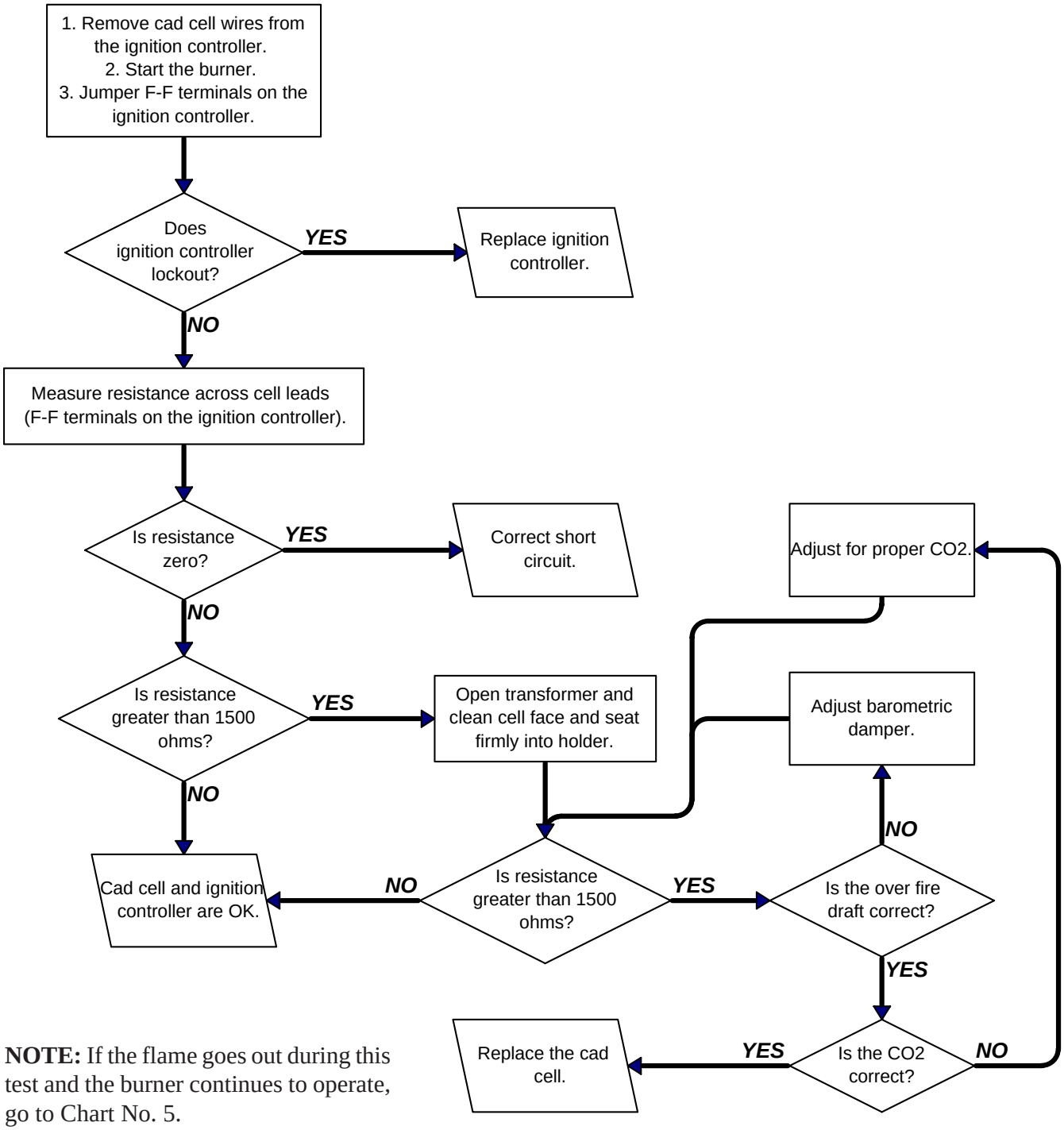
Replace any insulators that are questionable.

Transformer failures and ignition problem can be caused by the following:

- Excessive gap on the ignition electrodes. Gap should be 3/32".
- High ambient temperatures
- High humidity
- Carbon residue on the porcelain bushings
- Low input line voltage
- Arcing between the ignition electrodes and the transformer springs. They must have good contact.
- Carbon residue, moisture, crazing or pin holes on the insulators
- Improper positioning of nozzle in relation to the radius of the end cone
- Carbon residue on electrode parts

Troubleshooting Continued

Chart No. 4 - Burner ignites and burns steadily until the system goes into lockout.

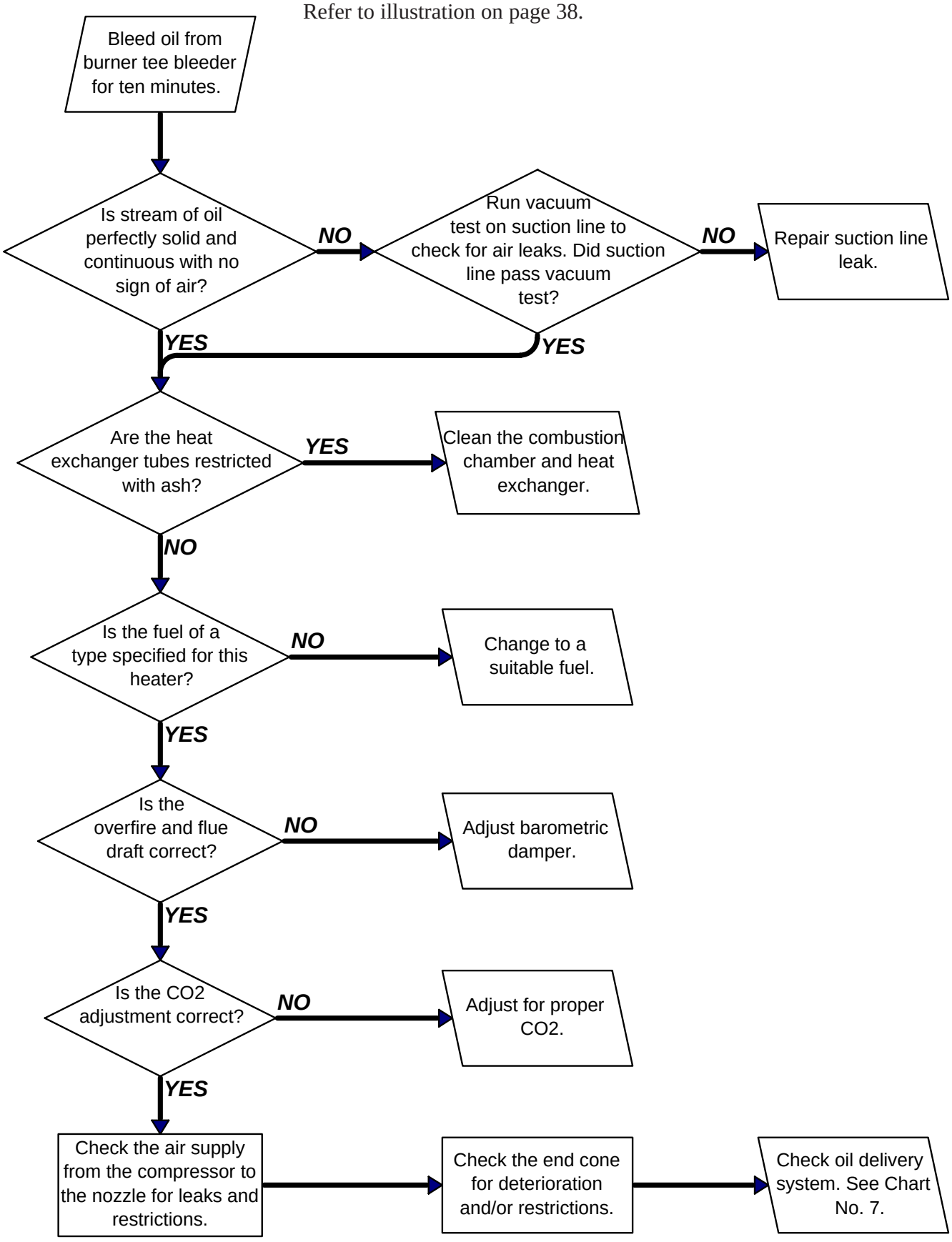


NOTE: If the flame goes out during this test and the burner continues to operate, go to Chart No. 5.

Troubleshooting Continued

Chart No. 5 - Thermostat calling for heat. Burner operation erratic/unstable flame pattern.

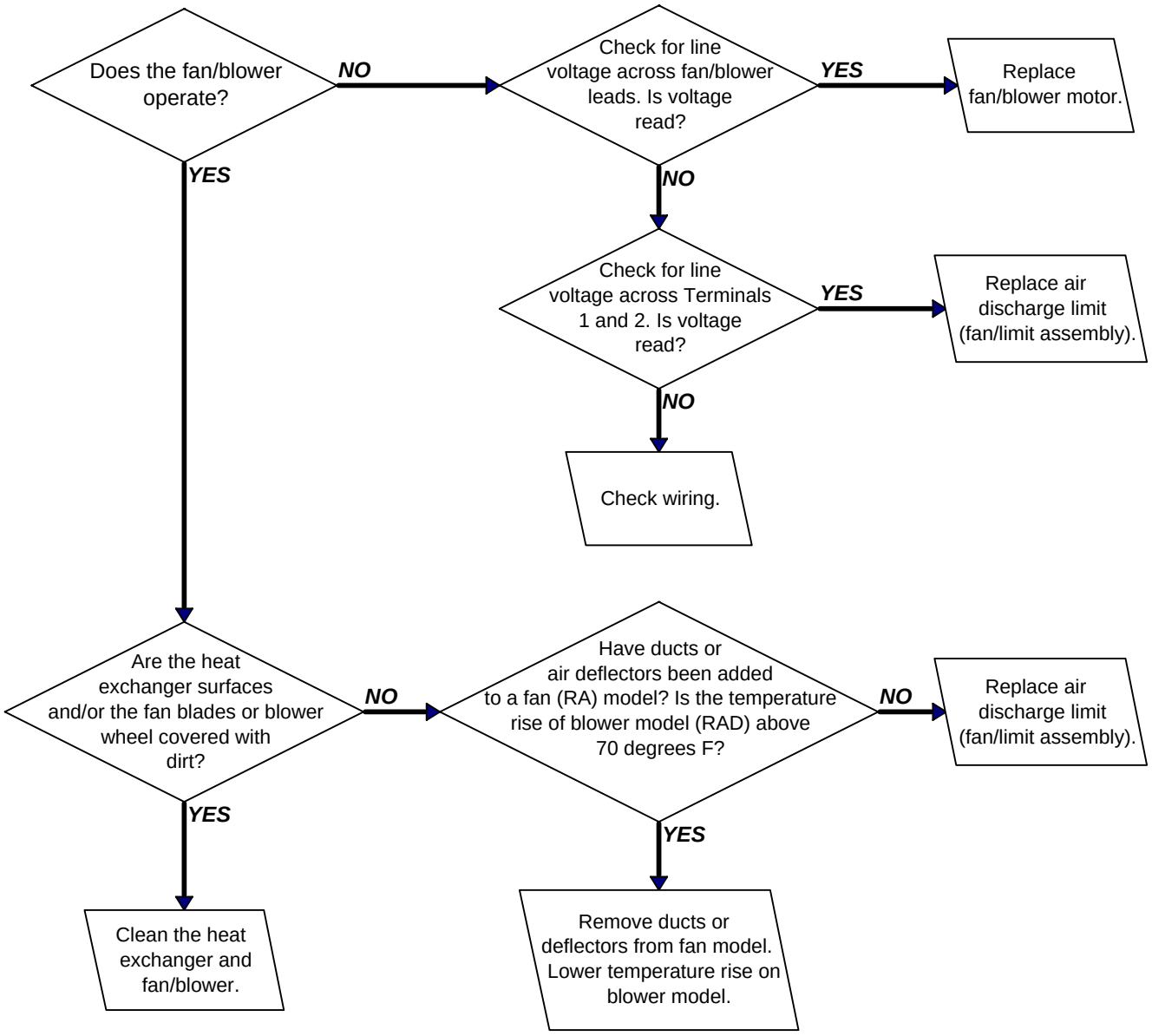
Refer to illustration on page 38.


Bleed oil from burner tee bleeder for ten minutes.
Is stream of oil perfectly solid and continuous with no sign of air?
NO
Run vacuum test on suction line to check for air leaks. Did suction line pass vacuum test?
NO
Repair suction line leak.
YES
YES
Are the heat exchanger tubes restricted with ash?
YES
Clean the combustion chamber and heat exchanger.
NO
Is the fuel of a type specified for this heater?
NO
Change to a suitable fuel.
YES
Is the overfire and flue draft correct?
NO
Adjust barometric damper.
YES
Is the CO2 adjustment correct?
NO
Adjust for proper CO2.
YES
Check the air supply from the compressor to the nozzle for leaks and restrictions.
Check the end cone for deterioration and/or restrictions.
Check oil delivery system. See Chart No. 7.

Troubleshooting Continued

Chart No. 6 - High Temperature Limit Cycles*

Refer to illustration on page 46.


Does the fan/blower operate?
NO
Check for line voltage across fan/blower leads. Is voltage read?
YES
Replace fan/blower motor.
YES
NO
Check for line voltage across Terminals 1 and 2. Is voltage read?
YES
Replace air discharge limit (fan/limit assembly).
NO
Check wiring.
Are the heat exchanger surfaces and/or the fan blades or blower wheel covered with dirt?
NO
Have ducts or air deflectors been added to a fan (RA) model? Is the temperature rise of blower model (RAD) above 70 degrees F?
NO
Replace air discharge limit (fan/limit assembly).
YES
Clean the heat exchanger and fan/blower.
YES
Remove ducts or deflectors from fan model. Lower temperature rise on blower model.

*High temperature limit cycles when internal temperature exceeds limit setpoint. Cause must be found and corrected for heater to function safely/ properly.

Troubleshooting Continued

Fan and Limit Controls

Model RA/RAD 140 and 235 heaters are equipped with a fan control and limit control assembly consisting of a specially designed control mounting bracket with a fan control, a circulating air high limit control, and a super high limit control attached. To access the fan and limit control assembly, remove the plate as illustrated. For service information, see Troubleshooting Chart 6, page 45.

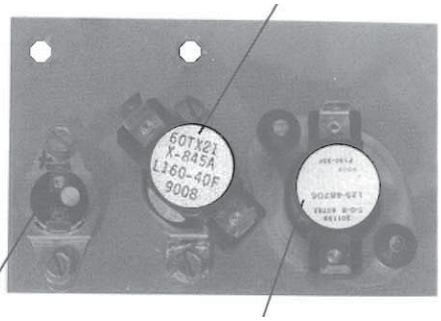
The main functions of the **fan/blower control** are to provide:

- Delay of fan or blower operation, preventing circulation of cold air at startup.
- Continued fan or blower operation as long as the unit temperature is above minimum setting. The fan/blower control also provides additional safety control by keeping the fan or blower in operation in the event that a malfunction would cause the oil burner to continue to fire when the thermostat is satisfied.

The **circulating air high limit switch** is nonadjustable and automatically cycles when the internal temperature exceeds the setpoint. For the heater to operate properly and safely, the cause for the temperature exceeding the high limit setpoint must be corrected.

The s**uper high limit switch** provides redundant control and is calibrated to open at a much higher temperature (350°F) than the standard automatic reset limit switch indicates a major failure caused by a malfunction of the primary safety controls or miswiring. Before attempting to re-start the heater the cause must be corrected and the fan and limit control assembly replaced.

Remove plate to access fan and limit control assembly.



Circulating Air High Limit

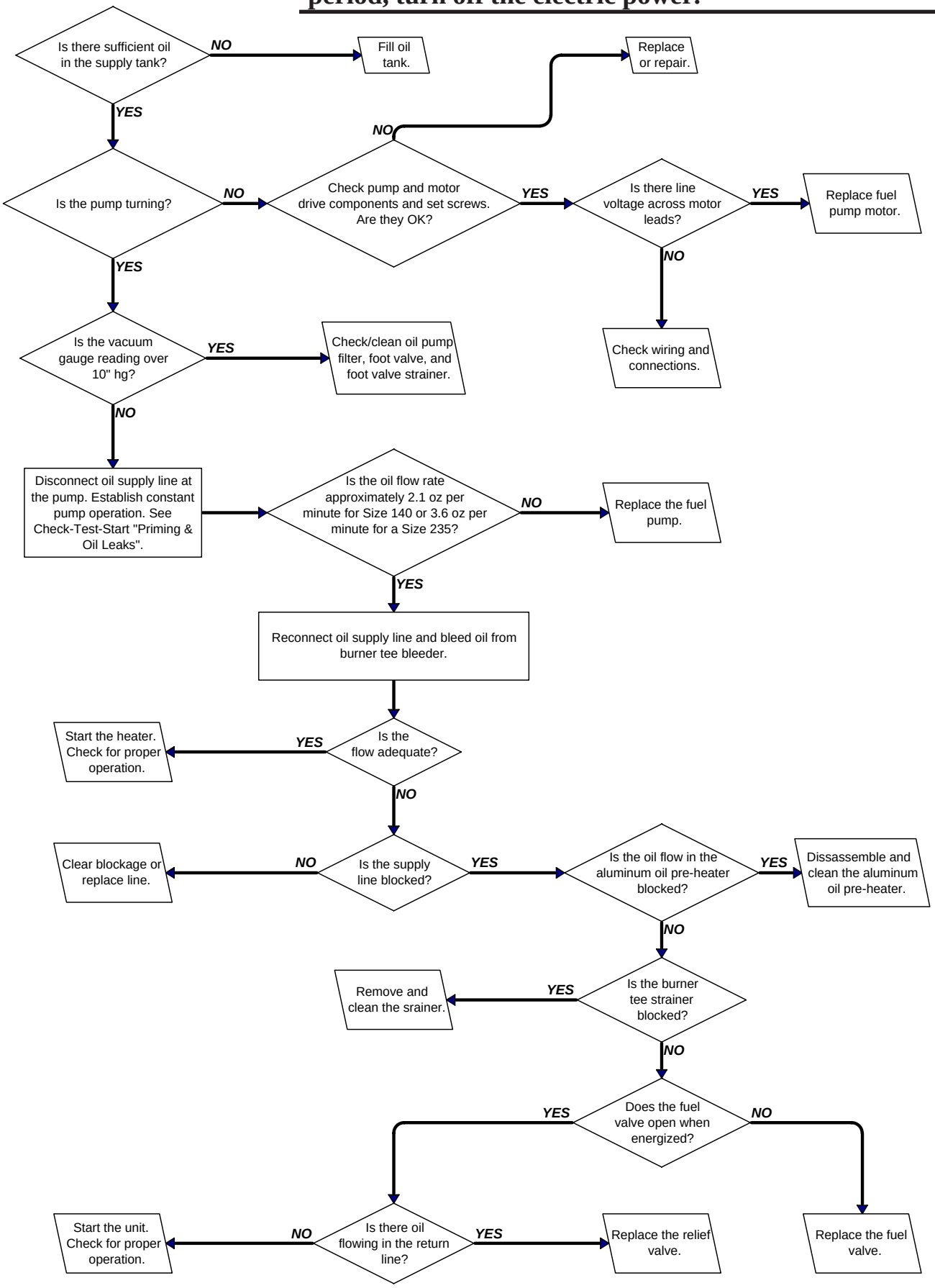
Super High Limit

Fan/Blower Control

Troubleshooting Continued

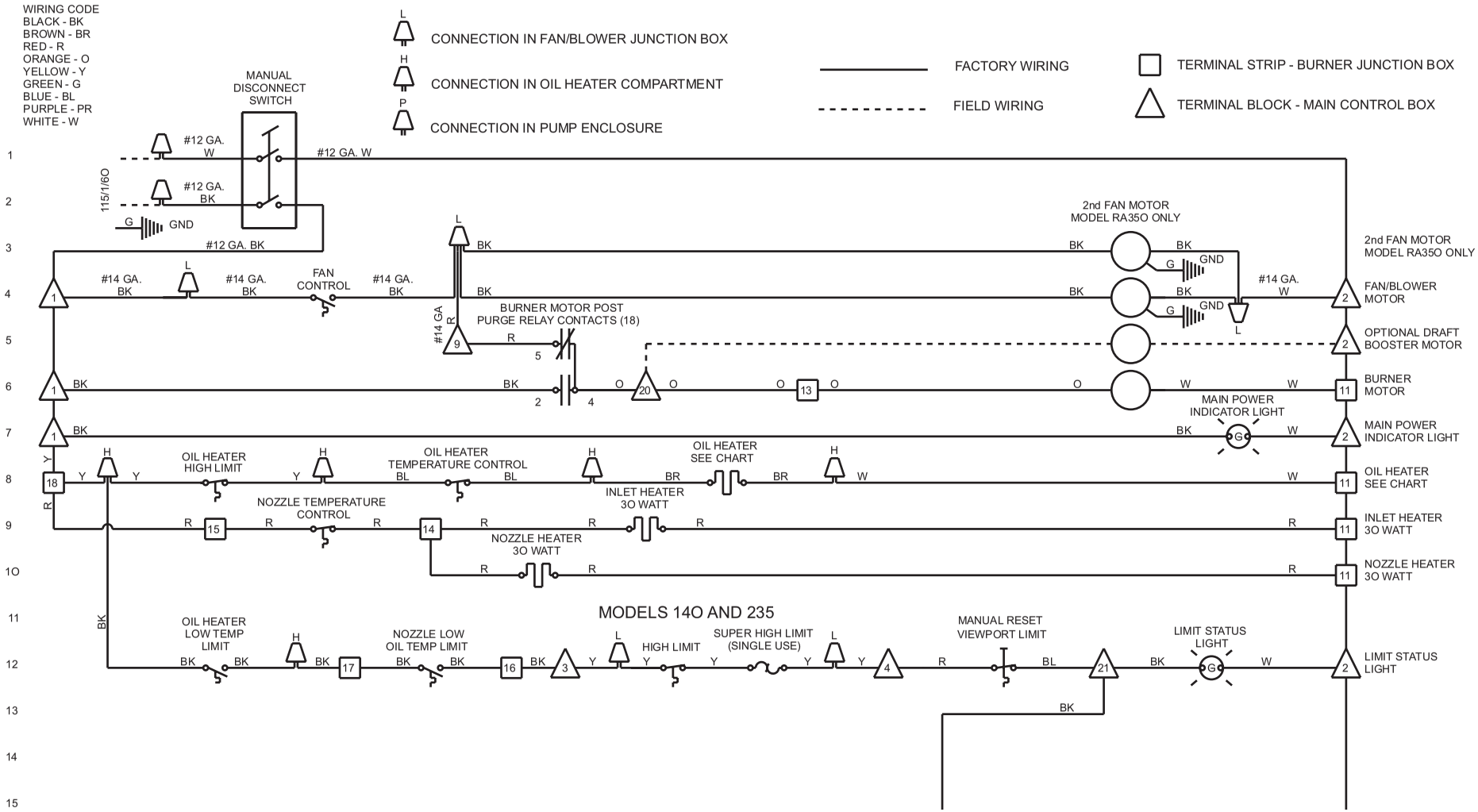
Chart No. 7 - Oil Delivery System

CAUTION: If the heater will be shut down for a long period, turn off the electric power.


Is there sufficient oil in the supply tank?
NO
Fill oil tank.
YES
Replace or repair.
NO
Is the pump turning?
NO
Check pump and motor drive components and set screws. Are they OK?
YES
Is there line voltage across motor leads?
YES
Replace fuel pump motor.
YES
NO
Is the vacuum gauge reading over 10" hg?
YES
Check/clean oil pump filter, foot valve, and foot valve strainer.
Check wiring and connections.
NO
Disconnect oil supply line at the pump. Establish constant pump operation. See Check-Test-Start "Priming & Oil Leaks".
Is the oil flow rate approximately 2.1 oz per minute for Size 140 or 3.6 oz per minute for a Size 235?
NO
Replace the fuel pump.
YES
Reconnect oil supply line and bleed oil from burner tee bleeder.
Start the heater. Check for proper operation.
YES
Is the flow adequate?
NO
Clear blockage or replace line.
NO
Is the supply line blocked?
YES
Is the oil flow in the aluminum oil pre-heater blocked?
YES
Dissassemble and clean the aluminum oil pre-heater.
NO
Remove and clean the srainer.
YES
Is the burner tee strainer blocked?
NO
YES
Does the fuel valve open when energized?
NO
Start the unit. Check for proper operation.
NO
Is there oil flowing in the return line?
YES
Replace the relief valve.
Replace the fuel valve.

Appendix

Wiring Diagram 147351 for Models RA/RAD 140/235



CONTROL TEMPERATURE LIMITS			
CONTROL	STYLE	ACTIVATE	RESET
FAN CONTROL	NO	135°F	1O5°F
HIGH LIMIT	NC	22O°F	45°F
OIL HEATER TEMP CONTROL	NC	17O°F	155°F
NOZZLE TEMP CONTROL	NC	16O°F	15O°F
OIL HEATER LOW TEMP LIMIT	NO	155°F	14O°F
NOZZLE LOW OIL TEMP LIMIT	NO	145°F	1O5°F
HIGH LIMIT (MODEL14O/235)	NC	16O°F	12O°F
SUPER HIGH LIMIT	NC	35O°F	N/A
FAN/BLOWER FAILURE LIMIT	NC	12O°F	9O°F
MANUAL RESET VIEWPORT LIMIT	NC	275°F	45°F

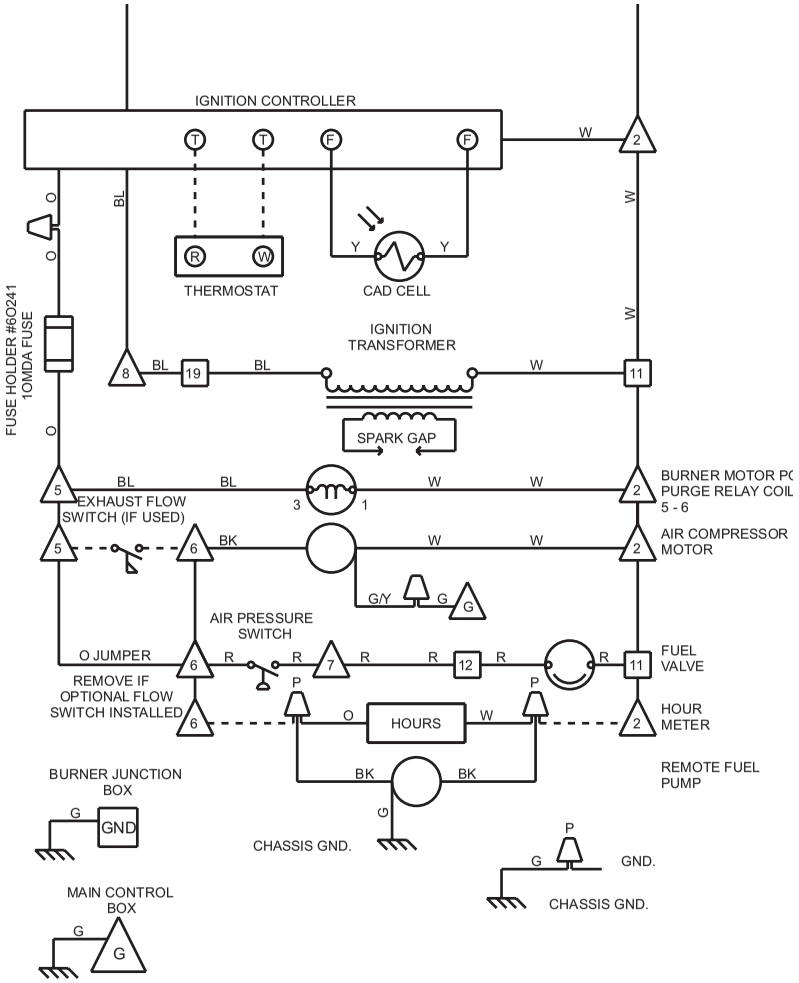
OIL HEATER CHART	
UNIT SIZE	OIL HEATER WATTS
14O	3OO
235	3OO

FIELD CONNECTION CHART				
SOURCE	TO LOCATION	COLOR	CONNECTION TYPE	GAUGE
115 V POWER SUPPLY	MAIN JUNCTION BOX	BLACK	WIRE NUT--BLACK WIRE	RA 12 MIN; RAD 8 MIN
115 V POWER SUPPLY	MAIN JUNCTION BOX	WHITE	WIRE NUT--WHITE WIRE	RA 12 MIN; RAD 8 MIN
115 V POWER SUPPLY	MAIN JUNCTION BOX	BARE/GRN	WIRE NUT--GREEN WIRE	RA 12 MIN; RAD 8 MIN
REMOTE PUMP	MAIN JUNCTION BOX	BLACK	TERMINAL BLOCK 6	14 MIN
REMOTE PUMP	MAIN JUNCTION BOX	WHITE	TERMINAL BLOCK 2	14 MIN
REMOTE PUMP	MAIN JUNCTION BOX	BARE/GRN	GROUND TERMINAL	14 MIN
THERMOSTAT	IGNITION CONTROL	WHITE	TERMINAL T1 SCREW	18 MIN
THERMOSTAT	IGNITION CONTROL	RED	TERMINAL T2 SCREW	18 MIN
OPT. EXHAUST BOOSTER	MAIN JUNCTION BOX	BLACK	TERMINAL BLOCK 19	14 MIN
OPT. EXHAUST BOOSTER	MAIN JUNCTION BOX	WHITE	TERMINAL BLOCK 2	14 MIN
OPT. EXHAUST BOOSTER	MAIN JUNCTION BOX	BARE/GRN	GROUND TERMINAL	14 MIN

SHORTENED SEQUENCE OF OPERATION

SEE INSTALLATION & OPERATION INSTRUCTIONS FOR FULL DETAILS

1. WITH POWER SUPPLIED AND DISCONNECT SWITCH "ON", OIL HEATERS PREHEAT OIL.
2. ON CALL FOR HEAT, THERMOSTAT CLOSES CAUSING IGNITION CONTROLLER TO ENERGIZE BURNER MOTOR, ATOMIZING AIR COMPRESSOR, REMOTE OIL PUMP AND IGNITION TRANSFORMER.
3. OIL IS IGNITED AND FLAME ESTABLISHED.
4. 3O - 45 SECONDS AFTER BEGINNING OF SEQUENCE, OR FAN CONTROL ACTIVATES AIR MOVING DEVICE(S).
5. WHEN THERMOSTAT IS SATISFIED, POWER IS REMOVED FROM IGNITION CONTROLLER, DE-ENERGIZING BURNER MOTOR, ATOMIZING AIR COMPRESSOR AND REMOTE OIL PUMP.
6. AIR MOVING DEVICE(S) CONTINUE TO OPERATE UNTIL EITHER HEAT EXCHANGER IS COOL (NOMINAL 3 MINUTES).
7. IF IGNITION DOES NOT OCCUR WITHIN 30 SECONDS THE IGNITION CONTROLLER WILL LOCK OUT. IF THE UNIT LOCKS OUT, RESET THE CONTROLLER BY PRESSING AND HOLDING DOWN ON THE RED RESET BUTTON FOR (4) SECONDS AND THEN RELEASING IT. DO NOT RESET MORE THAN ONE TIME !



147351
REV. #11

CAUTION: IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRING MATERIAL HAVING A TEMPERATURE RATING OF AT LEAST 105°C. EXCEPT FOR HEATING ELEMENT, FAN CONTROL AND LIMIT WIRING WHICH MUST BE 150°C.

RA(D) 140-235 DWG. #B-147351 REV. #11

(Note: W.D. 147351 covers Sizes 140, 235, and 350. Size 350 information has been removed in this publication.)

Hour Meter/Cleaning Record

Cleaning Date	Meter Reading	Initials	Cleaning Date	Meter Reading	Initials

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FOR SERVICE OR REPAIR, FOLLOW THESE STEPS IN ORDER:

FIRST: Contact the Installer

Name _____

Address _____

_____

_____

Phone _____

SECOND: **Contact the nearest distributor** (See Yellow Pages). If no listing, contact Authorized Factory Representative, 1-800-695-1901 (Press 2).

THIRD: Contact: REZNOR®/Thomas & Betts Corporation
150 McKinley Avenue
Mercer, PA 16137
Phone (724) 662-4400

Model No. _____

Unit Serial No. _____

Date of Installation _____

Thomas&Betts

(800) 695-1901 Press 2
www.ReznorHeaters.com

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8/05 Form RZ-NA I-RA/D 140/235 (Version A.2)